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POWER MISCELLANY

SEPTEMBER, 1938

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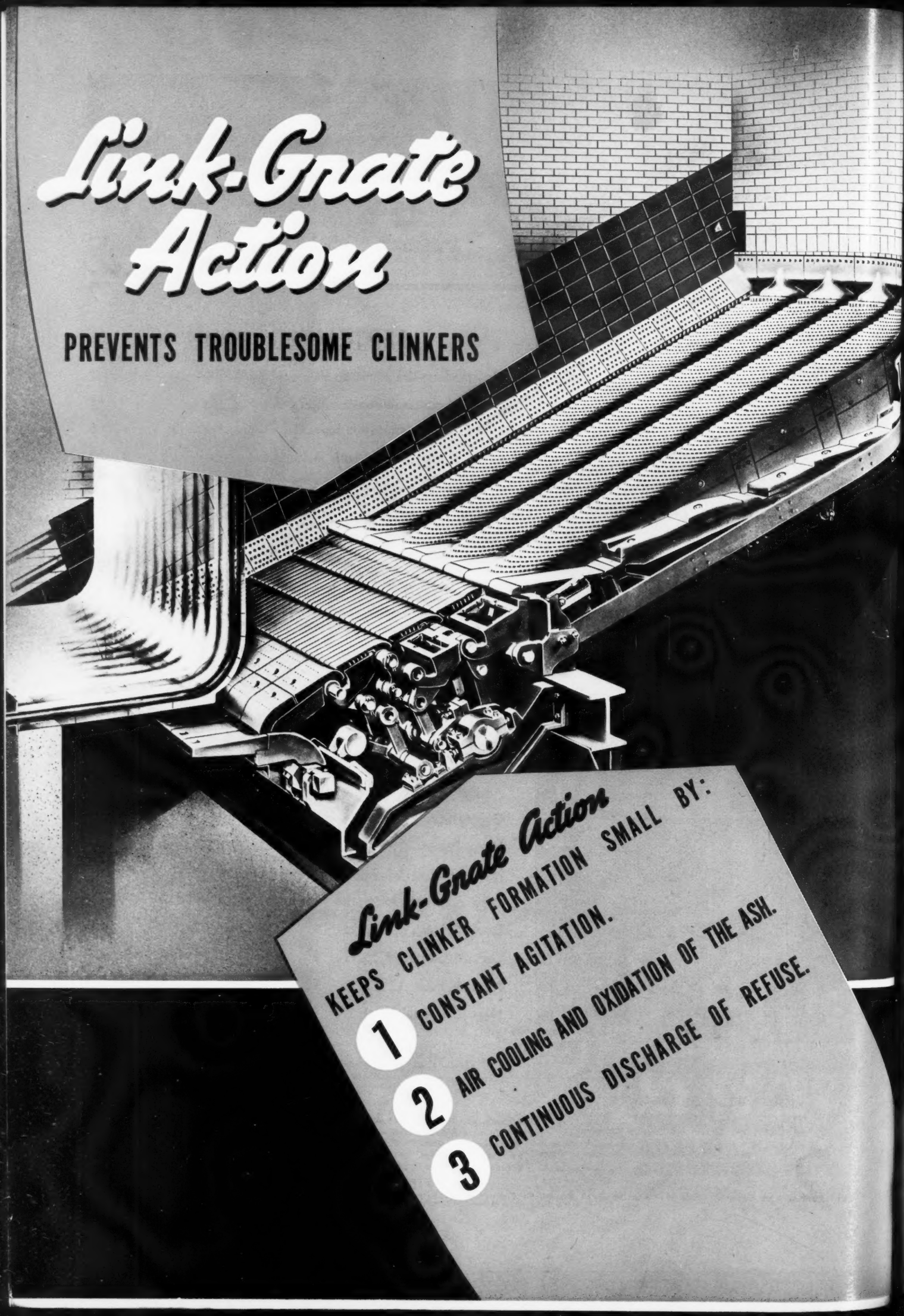
Link-Grate Action
PREVENTS TROUBLESOME CLINKERS
Link-Grate Action
KEEPS CLINKER FORMATION SMALL BY:
1 CONSTANT AGITATION.
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POWER

Established 1882 PHILIP W SWAIN, Editor

Royal Road

SAID EUCLID to King Ptolemy I, "There is no royal road to geometry". Thus spake the father of geometry twenty-two centuries ago, and the king believed him. Many still do, but we don't. We propose to debunk this quaint notion that one must eat the whole educational cake, or go hungry.

Our purpose is not so much to undermine a time-honored slogan, as to render a practical service to the thousands of power engineers who have reached responsibility through experience alone. Too often such men are frightened away from the so-called theoretical studies by the myths of the schoolmarms.

Here are some facts worth knowing. First, the practical man who masters also the basic theory of his job adds many thousands of dollars to his life's potential earnings (check this statement by observing which men move ahead). Second, picking up a little education on the side is not half as tough a job as it's made to appear by some of the educators and the so-called "educated".

Most of the barriers to scientific learning are purely artificial—man made. It's an obstacle race. The program committee won't let a man walk comfortably from A, where he is, to B, where he wants to go. Instead it puts a sack over his head, ties his legs together and warns him that he'll have a mighty tough time. He will, that way.

After many years of close observation of educational processes, we have acquired a profound respect for real knowledge and an equally profound disrespect for the snobbery and fol-de-rol of much so-called "education". Half innocently, many of the truly educated, along with those who use the same label on an empty can, have built themselves into a sort of exclusive club with trick entrance requirements, passwords, secret codes, hoods and nightgowns to scare off the uninitiated.

Let's be specific. Take trigonometry! If you are a technical graduate you spent a lot of time on that subject. What did you get out of it? Sines, cosines, tangents; a practical understanding of these three represents 75% of the value you received. Using the barn roof, a yardstick and a simple table of *natural* functions, how long would it take you to make their practical use clear to any carpenter or tool-maker with a common-school education? Three hours at most.

Next look at the slide rule. Here's a practical engineer of forty who can't operate it. How long would it take you to teach him to work multiplication, division, proportion, squares and square roots? No talk about logarithms—just plain every-day English and elbow grease, as if you were teaching your son to run a cross-cut saw. Three hours drill would give the man a *working* knowledge of these operations. How much would this new skill be worth to the engineer through the remainder of his working life. At least $5,000—a mighty attractive return on the investment of three hours time and the price of a rule.

Apply some paint remover to descriptive geometry—"nightmare" of college students. Is it really so difficult to explain why the front view looks one way on the blue print, the side view another way and the top still another?

Exactly the same condition exists with algebra, geometry, electricity, chemistry, etc. Ten per cent of the usual textbook material contains ninety per cent of the benefit as far as the daily job is concerned.

When this fact sinks home in the mind of the practical man without formal education, he is set to go a long way with a moderate and reasonable effort. His biggest job, and this is the sad part of it, is to find a teacher or a book that will blow away the fog so he can see the dock.

Coal Takes a Ride

Here's how various coal-handling systems do the job of moving fuel from rail to bunker or to and from storage for medium-size plants

By W G HUDSON
Engineer, Link-Belt Co

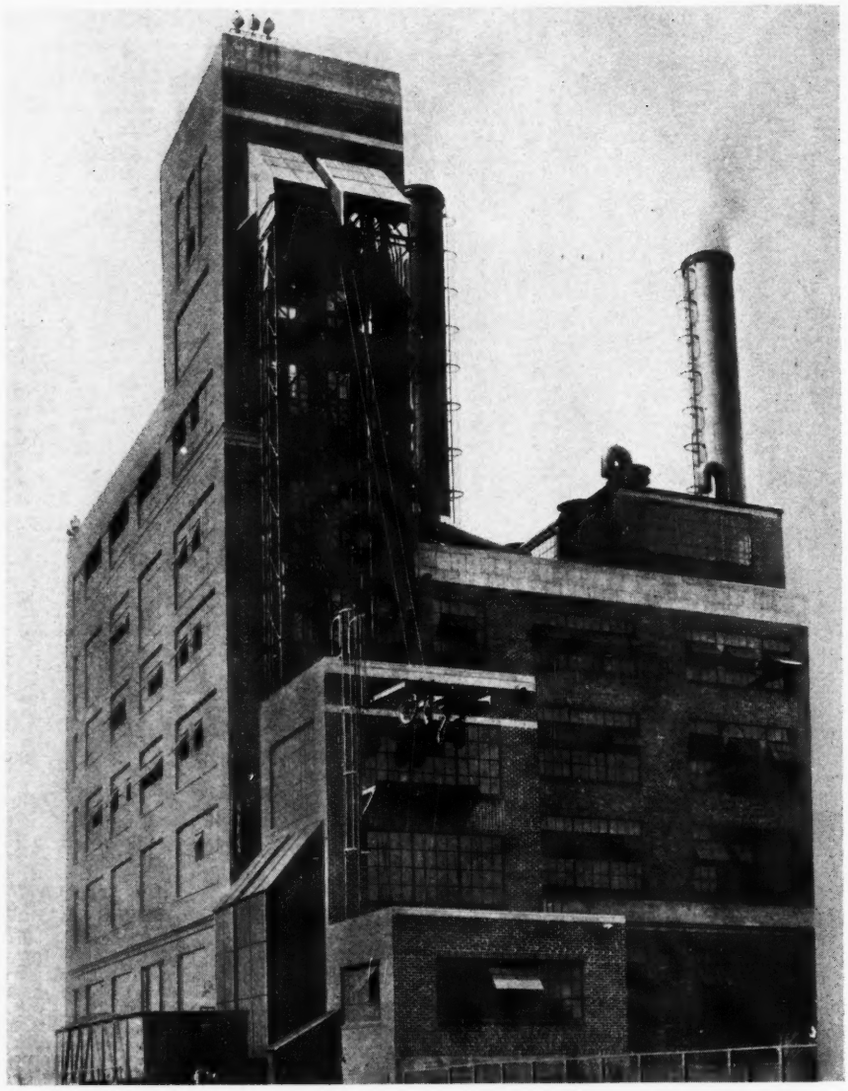


Fig. 1—A high-speed balanced skip hoist handles 300 tons of coal per hr at a bucket speed of 260 fpm

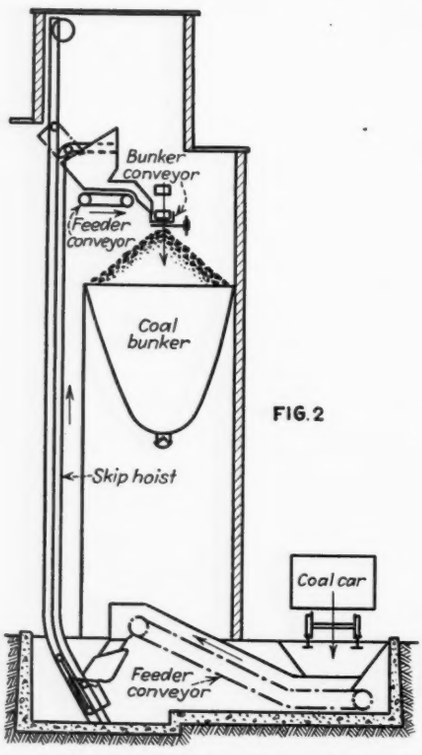


FIG. 2

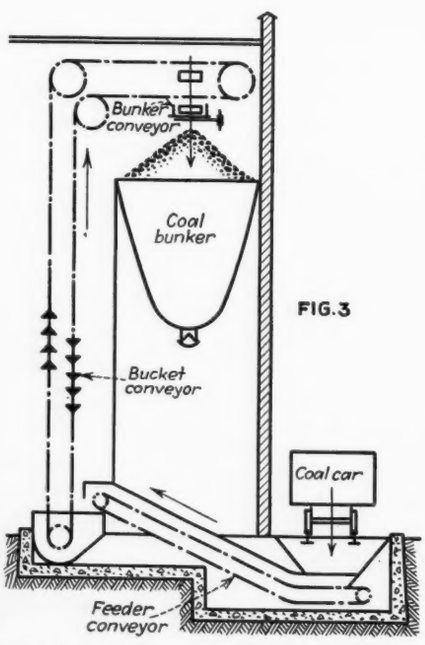


FIG. 3

Figs. 2 and 3—Comparison of skip hoist and gravity-discharge elevator in combination with feeder and distributing conveyors

COAL-HANDLING equipment for the larger stations, in the range between 5000 and 35,000 kw varies widely. Characteristic features are so different that a comprehensive analysis would be exhaustive. Unloading and handling of water-borne coal is alone a broad field, so this article will be restricted to some typical layouts for stations receiving coal by rail.

Larger stations entail the following factors: rapid discharge of cars, high rates of handling, provision for reducing lump coal to sizes convenient for pulverizing or for stokers, removal of foreign material, and large reserve storage to guard against interruption of supply.

How quickly hopper-bottom cars can be emptied determines the coal-handling rate. Information from operating men is in practical agreement that four men can unload four 70-ton cars per

hour, either of run-of-mine or slack, reasonably dry. 70-ton cars unload more rapidly than smaller ones and run-of-mine generally flows more freely than fine coal. One report gives an unloading rate under favorable conditions of two cars per hour with three men, with the limit fixed by time required to shift cars into and out of position.

Fine coal flows slowly when wet. In freezing weather unloading is arduous to say the least. Large track hoppers, car hauls, and twin dump tracks are advantageous. The latter are particularly so, with wet and sticky coal. Rotary car dumpers speed up rate of unloading, but cost limits them to plants larger than those under consideration here.

In a discussion at the Pittsburgh meeting of the ASME (October, 1937), reference was made to the difficulties sometimes resulting with wet coal, first in unloading from cars and again in the pulverizing mills. To these problems might have been added tendency to arch in bunkers and freeze in outside storage. Oil-treated coal reduces the difficulties to an extent which may justify the price premium. If belt conveyors are involved, synthetic rubber facing is necessary to reduce the disintegrating effects of oil.

Usual Equipment

Crushing units are not so necessary today as they were formerly because coal in prepared sizes is always available. However, coal exposed to freezing temperatures is usually lumpy, which may mean using a crusher with bypass. Again, aside from the function of crushing coal to size, a Bradford breaker or a hammermill serves to remove rags, straw, wood, iron, etc.

Where requirements range from 100 to 200 tons per hour (a coal consumption of 800 to 1600 tons per day, since there is an advantage in handling normal 24-hour supply in one shift), coal-handling equipment usually comprises a high-speed belt conveyor, a slow-speed pivoted bucket carrier or elevator, a medium-speed flight conveyor, a skip hoist, or a combination of these units.

A belt conveyor readily handles large tonnages, but requires an extended area in which to attain necessary elevation, as 18 or 20 deg is the maximum slope. This may be an advantage because coal dust from car dumping is removed from generators and switchboard. A belt conveyor is open to possibility of costly damage, not the case with a pivoted-bucket carrier or flight conveyor.

Balanced Skip Hoist

A balanced, high-speed skip hoist with automatic slowdown at the terminals is standardized for large capacities. Thus, for a 100-ft lift with 120-cu ft buckets, at 260 fpm, capacity is 300 tons per hour. The skip hoist has a decided advantage for extremely high lifts, Fig. 1. Small weight of moving parts and simplicity are desirable features. However, the usual requirement is a lift followed by horizontal distribution. Here the skip introduces an undesirable feature, shown by Figs. 2 and 3, giving two layouts for the same job, for 150 tons per hour.

In Fig. 2, coal flows to the apron feeder continuously, from the feeder to the skip bucket intermittently, from the skip bucket to the upper feeder intermittently, and from this feeder to the bunker conveyor continuously. Therefore, rate of coal flow changes four times from car to bunker, requiring surge hoppers between intermittent- and continuous-flow points, and a loss of efficiency with increased wear due to flow changes. The layout, Fig. 3, with gravity-discharge elevator, gives a continuous flow from car to bunker, with fewer elements, greater efficiency, lower operating expense, and 20% less investment.

A belt conveyor has one inherent feature frequently desirable for stations subject to extension. These usually are planned for additional power units in line, which will call for increased coal-handling capacity and a lengthened conveyor. A 36-in. belt conveyor at 400 fpm has a capacity of 500 tons per hour. This may be the contemplated eventual rate of handling, but a capacity of 250 tons per hour may be sufficient for some years. Conveyor belts are costly, and a 36-in. belt running at 400 fpm involves a needless investment. As an alternative, install 36-in. machinery with a 30-in. belt at 300 fpm. Later, this equipment can be speeded up by a simple change at the drive, which will take care of necessary capacity increases up to 400 tons per hour, before it becomes necessary to change to a 36-in. belt. Fig. 4 shows a 36-in. belt carried on 42-in. idlers. An interesting detail in this conveyor gallery is the continuous sash, giving excellent light.

Bluffton Layout

Fig. 5 shows the layout at the stoker-fired station of the Northern Ohio Public Service Co at Bluffton. Sargent & Lundy are the engineers. This has an initial capacity of 5000 kw with steam at 425-lb pressure. Coal received from cars is fed by a reciprocating feeder to an inclined flight conveyor, from which it is discharged to a belt conveyor either directly or through a crusher. Or, if discharge is made at the head of the flight conveyor, there forms the initial pile for the drag-scraper storage system that provides a 15,000-ton reserve.

The main conveyor has an 18-in. belt at 200 fpm with a rated capacity of 50 tons per hour. The system has a magnetic pulley and also provision for a weightometer to record weight of all coal passing to the bunkers.

The pivoted bucket carrier, Fig. 6, where it can be used, is a remarkably efficient machine. Many of these have been in service for several years with reports of maintenance cost ranging from negligible to a small fraction of a cent per ton handled. Where a run-around path is permissible, both coal and ashes are handled with little increase in upkeep cost. While standard listed carrying capacities do not reach

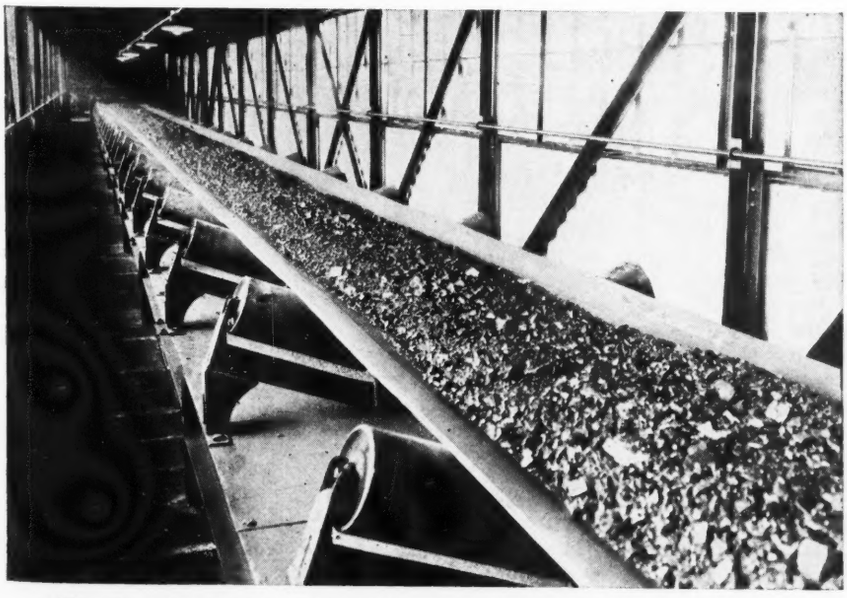


Fig. 4—36-in. belt on 42-in. idlers permits later increase in capacity

those of belt conveyors or skip hoists, they range from 20 to 280 tons per hour at 50 fpm for the usual carrier sizes.

The layout, Fig. 7, is for an industrial power plant with an initial installation of 2 boilers, each rated 90,000 lb of steam per hour. Additional boilers will be installed later. The storage arrangement here provides four 400-ton supplementary storage bins, a service bin of 160 tons, and a 75-ton ash bin. Coal is discharged into two track hoppers with independent apron feeders serving a 24x20-in. runaround carrier, which at 40 fpm has a capacity of 70 tons per hour.

Normally, coal is delivered to the active bunker, but any surplus is deposited in one of the supplementary bins. Each bin has an independent feeder, for rehandling to the active

Fig. 6—Overlapping pivoted-bucket conveyor discharges coal to a 24-in. belt conveyor

bin. If coal in the lower section of any bin begins to heat, it may be recirculated and cooled. Between coal-handling periods, the dumper is spotted over the ash bin. Ashes are delivered to the lower run of the carrier by a slow-speed drag conveyor extending at right angles, back across the ash-pit fronts.

Provisions have been made against any probable interruption of coal supply. The pivoted-bucket carrier is practically foolproof. Either track-hopper feeder can carry on if the other is cut out of service, and the four reserve bin feeders are independently driven.

Usually, boiler-house design provides for overhead bunkers with live storage sufficiently large to eliminate, as far as possible, necessity of stocking out coal and rehandling it. A larry, preferably motor-driven, makes the coal in any section of the bunker available for any

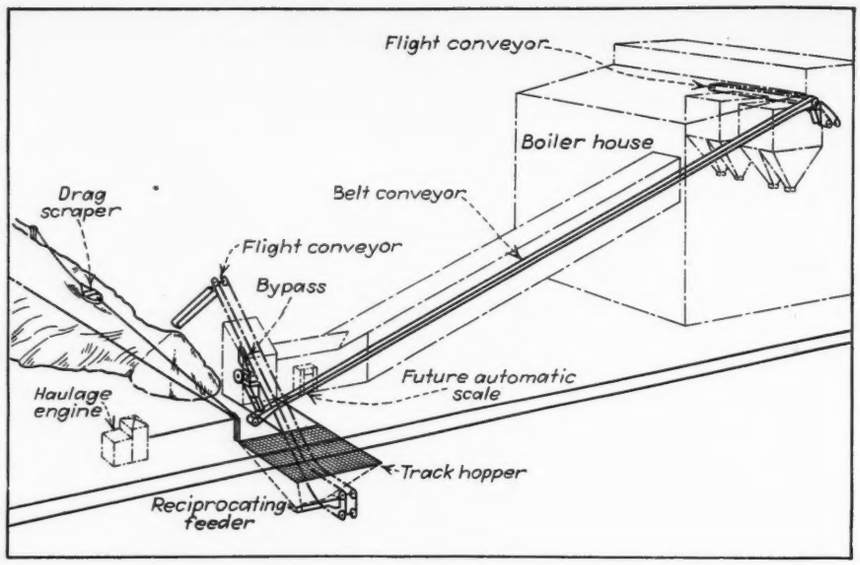


Fig. 5—Coal-handling and storage layout for a plant with 5000 kw initial capacity

stoker or pulverizer hopper. A variation of this arrangement is a conveyor beneath the bunker bringing the coal to an automatic scale that discharges to a return conveyor feeding the stoker or pulverizer hoppers. This may be made fully automatic, requiring no attention other than opening the discharge gate of the hopper to be served.

As with nearly every other piece of mechanical equipment in the generating plant, the coal-handling installation must be dependable. Added investment for high-class equipment will show a handsome return in the long run. For the difficult service of handling both coal and ashes, the pivoted-bucket carrier has an enviable record, as proved by many maintenance records extending over 20 to 30 years.

This article has attempted to show coal-handling installations adapted to the usual requirements of plants in the middle range of generating capacity. No two stations have exactly similar conditions, and the arrangement of coal-handling equipment best suited to each job can be determined only through a comprehensive engineering study based on general requirements set up by plant designer and architect.

THE *ladder of life is full of splinters, and they always prick the hardest when we're sliding down.*—William L Brownell

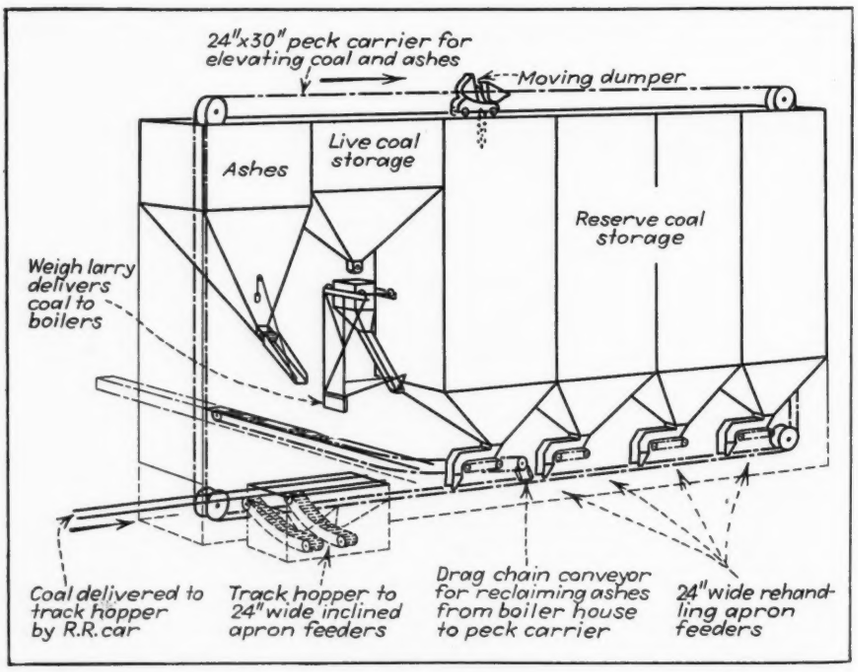

24"x30" peck carrier for elevating coal and ashes
Moving dumper
Ashes
Live coal storage
Reserve coal storage
Weigh larry delivers coal to boilers
Coal delivered to track hopper by R.R. car
Track hopper to 24" wide inclined apron feeders
Drag chain conveyor for reclaiming ashes from boiler house to peck carrier
24" wide rehandling apron feeders

Fig. 7—A 24x30-in. runaround pivoted-bucket conveyor handles both coal and ashes at 40 fpm

Controls Needn't Be Goldplated

Savings from small outlays sound good to the boss; asking for fancy gadgets may mean getting nothing

By STUART W ALLEN
Consulting Engineer, Providence, R. I.

"I'D LIKE to reduce boiler house costs, but the remedy seems worse than the disease", was the comment of the manager of a fair-sized industrial plant with whom I talked recently. Discussion of today's keen competition led to the usual condemnation of the power plant as one of the largest single items of expense, and my friend bemoaned the fact that it seemed necessary to goldplate everything in the power house to better results.

A little questioning revealed that the chief engineer had recently visited an exposition of power-plant equipment and had stopped off on the way home to visit some central stations. The jaunt had convinced him, rightly, that combustion control would save fuel and labor dollars. His error was that he failed to appreciate the differences between the plants he had visited and his own; the equipment he recommended was suitable for a much more complicated and refined plant.

His plant was burning oil, on natural draft, a simple arrangement complicated only by rather rapid and excessive load swings. The fireman had to be on his toes to maintain pressure, so a second man was needed, although there was not enough to keep him really busy. Few, if any, CO_2 readings were taken, and while some attempt was made to keep furnace draft as low as possible, this was of secondary importance in the routine.

The net result of this conversation was that readings were taken showing CO_2 varying from 4 to 10½%; occasionally CO_2 went up and CO was present. A check of boiler-room duties indicated that one man could easily handle the boiler room if he didn't have to be continually on the jump trying to hold steam pressure. All of this bore out the recommendations of the chief engineer.

Firing equipment was adequate; each of three hrt boilers was equipped with a single steam-atomizing burner. Pumping and handling equipment also met requirements, and oil temperature was held within reasonable limits. However, there was no consistent check of the oil to determine any variation in quality which would require a change in temperature to maintain constant viscosity.

After evaluating the maximum saving possible by the most advanced methods of firing, taking into account the above facts and the quality of labor available, it was decided to make the control installation simple.

A hydraulic damper regulator was connected by shafting and chain to fuel valves, steam valves, and ashpit and uptake dampers. Individual connections were made so that damper settings could be adjusted in relation to burner settings, at a number of points in the range. It looked as if 13.5% CO_2 would give best results in boiler efficiency and effect on refractories; swinging each boiler from highest to lowest rating gave a close approximation. Greatest variation from 13.5% was much less than 1%.

Adjustable Fuel Valves

If this closeness could be maintained over a year's operation, little more could be desired, but differences in atmospheric pressure, furnace draft, fouling of fire tubes, and other causes produce some variation from original settings. In this case, however, greater refinement in control of air could not be justified when other variations, such as minor changes in oil viscosity would cause greater variations in the fuel-air ratio. Utilizing adjustable fuel valves took care of this condition; a correction could be made at the burner to produce proper ratio when any considerable variation appeared.

A check of 12 month's costs indicates a net fuel saving of 10%, a little greater than would be expected by the improvement in CO_2. That a steadier fire is maintained, that there is no alternate heating and cooling of the setting, and that the operating force has both more time and more incentive to keep equipment in condition, all contribute to this saving.

Besides the direct fuel saving, the transfer of one man from the power-plant payroll to the machine shop meant a substantial reduction in labor costs. Other less easily evaluated savings include lower refractory maintenance. Observation shows considerably less deterioration of refractory than over any similar period of operation. Still another gain is that less steam is required for atomization; the amount is held within close limits for each fuel-valve setting as compared with the old "guess and try" method.

This plant story isn't told to advocate any kind of installation, but merely to point out that equipment must fit the job, and that, in this case, the chief engineer was damaging his chances of getting much needed improvements by asking for more than could be financially justified.

On the other hand, in a plant where fuel-oil heating and pumping equipment was carefully controlled, and where steam load was larger than in the previous case, it was found that equipment to control air flow under all weather and operating conditions was fully justified. In this case, also a natural-draft installation, furnace-pressure regulators were applied; a connection being made from the master control shaft to each regulator. Regulators were designed to give predetermined furnace draft for each setting, and with reasonably constant atmospheric conditions in the boiler room, accurate control of air passing through the burners resulted. Since uncontrollable variations would have more effect than slight changes in boiler-room air pressure, no further refinements were added.

It would be possible to go on describing individual jobs, each differing in some respects from the others, but the only result would be to bring home more forcefully that each has one thing in common—each was engineered to fit existing equipment, operating conditions, and personnel. Each demonstrates again that a careful analysis of local conditions leads to a financially sound argument that will obtain the boss's confidence.

Steam in Winter—Diesel in Summer

That's the combination that makes operation economical in the plant built and designed by operators at Pillar of Fire, Zarephath, N. J.

BY SMARTLY matching prime-mover-performance characteristics against demands for power and heat, operators of the power plant at the Zarephath, N. J. headquarters of the Pillar of Fire, a religious organization, secure operating economy, and by handling most of the design and construction themselves, they have modernized their plant at minimum cost.

The high antenna of radio station WAWZ, operated by Pillar of Fire, is a landmark in the countryside near Bound Brook, marking the location of Alma White College, Alma Preparatory School, and Zarephath Bible Seminary. On the extensive grounds are dormitories, an administration building, a publishing building, and a new Seminary building now under construction. The power plant supplies light, power, heat and hot water to all these buildings, electricity to the independently heated greenhouse, garage, bakery, and blacksmith shop.

Prior to modernization, the power plant comprised two boilers and two old steam engines. Exhaust was used for heating; some power was purchased. Changes in the plant, long viewed as desirable, were precipitated by need for illumination on the radio antenna, to prevent aviation accidents at night. This meant adding a sizable block of load, which would have to be purchased at a straight lighting rate. The high operating costs involved in this arrangement and the fact that other power purchases were made at unfavorable rates because of the heavy proportion of lighting, all pointed to an increase in generating capacity as the best solution.

A study of the conditions revealed that the most economical plan of expansion would be to have enough steam-engine generating capacity to supply exhaust for winter heating needs, and to generate additional power requirements by diesel. Steam engines in the plant at the time were old and ready for replacement, but it was decided to install the diesel first.

Considerable time was spent by H R Sutton, chief engineer, and G C Green, machinist of Lambertville, N. J., in surveying engines available, including visits to many plants to see engines in operation. The conclusion was that the single-cylinder horizontal Ruston-Hornsby engine shown in Fig. 1 was best for conditions at Pillar of Fire. This English-made engine appealed because of its simplicity of construction, ruggedness, and slow-speed; all pointing to smooth operation and low maintenance.

First step in modernization was to get the diesel installed. This job was handled by Mr Sutton and Mr Green with local help. The 11¾x21-in. 275-rpm, 57-hp, air-starting engine is shown on its foundation in Fig. 1. It is direct-connected to an Electrical Machinery Mfg Co 45-kva generator. The generator shaft drives, through V belts, an exciter and a small dc generator supplying current for printing presses in the publishing building.

New Steam Engine

Next step was to replace the smaller of the two old steam engines with an Erie City unaflow engine bought from the United States government (Fig. 2). Although about 25 years old, the engine was in first-class condition as it had been used as a standby unit at Fort Hancock. This 13x12-in. prime mover drives a 75-kva General Electric generator, also V-belted to an exciter and a dc generator. With this unit in service, the second of the old steam-engines was removed and engine-room modernization was about complete.

The original oil-fired boilers (approximately 1000 sq ft each) were retained, as their steaming capacity was adequate. Revamping to increase efficiency is the order of the day in the boiler room, however. The National

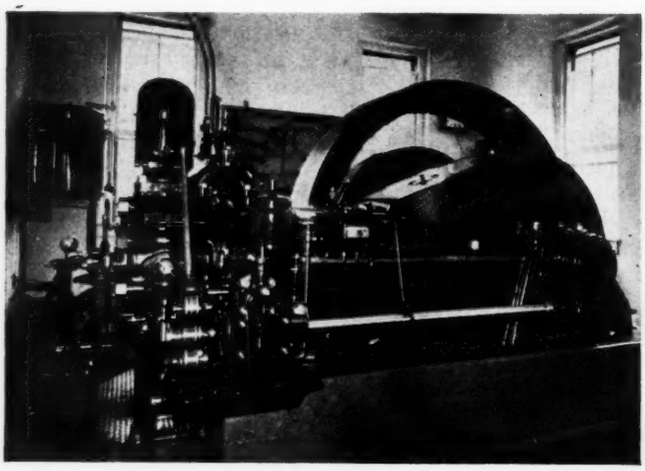


Fig. 1—Single-cyl horizontal diesel handles summer loads; jacket water and exhaust help heat hot water

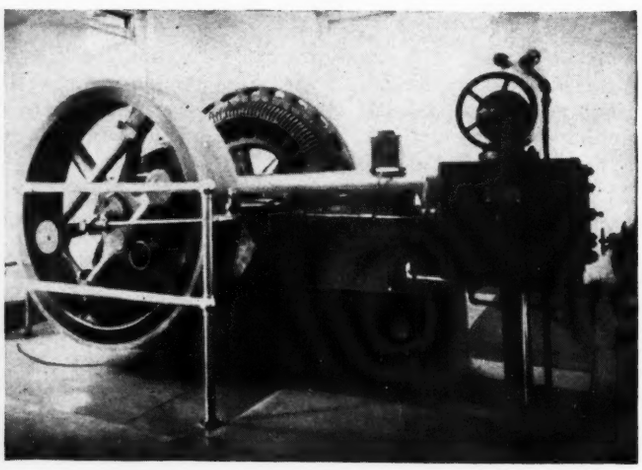


Fig. 2—Need for exhaust steam to heat buildings make this unaflow engine most economical prime mover in winter

Airoil steam-atomizing burner on one unit has been lowered; better combustion and longer refractory life are the result. The other will be lowered in a similar manner as soon as possible.

The flow diagram, Fig. 3, shows how steam and diesel combine to give a high degree of operating economy. Bunker C oil, delivered by truck, is stored in a 6500-gal. tank, heated by exhaust from the steam-driven fuel-oil pumps. Boilers generate steam at 90-100 lb, supplying engine, steam pumps, hot-water-heating tank, and laundry. Exhaust from engines and pumps passes to an exhaust header feeding the building-heating system and the open feedwater heater. During winter months, the engine runs at close to full load for about 15 hours a day. Nearly all exhaust goes to building and water heating, so power generation is nearly all byproduct. When steam and hot water needs fall off during the rest of the day, the diesel picks up the power load.

In summer months the diesel runs day and night; one boiler is carried to help with water heating and supply small process-steam requirements. A glance at the diagram will indicate how diesel waste heat is utilized. Water from the storage tank, after softening, flows through a heat exchanger, cooling jacket water for the engine. With a closed jacket-water circuit, no scale troubles are expected. Water from this heat exchanger then flows to the hot-water tank. Exhaust from the engine gives up heat in another exchanger in which water from the hot-water tank circulates, and then passes into the brick stack which serves as muffler.

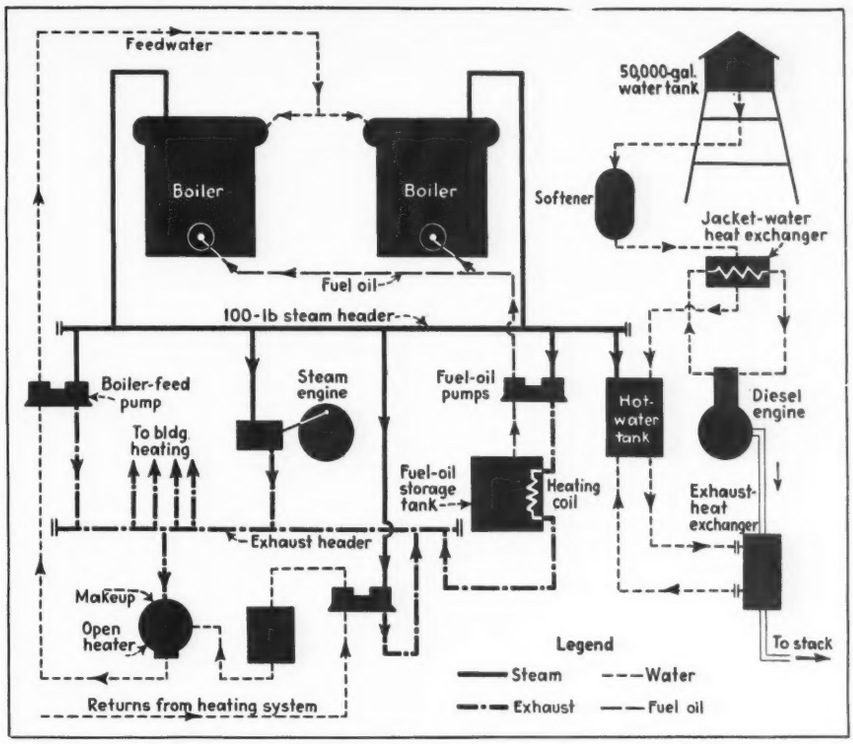
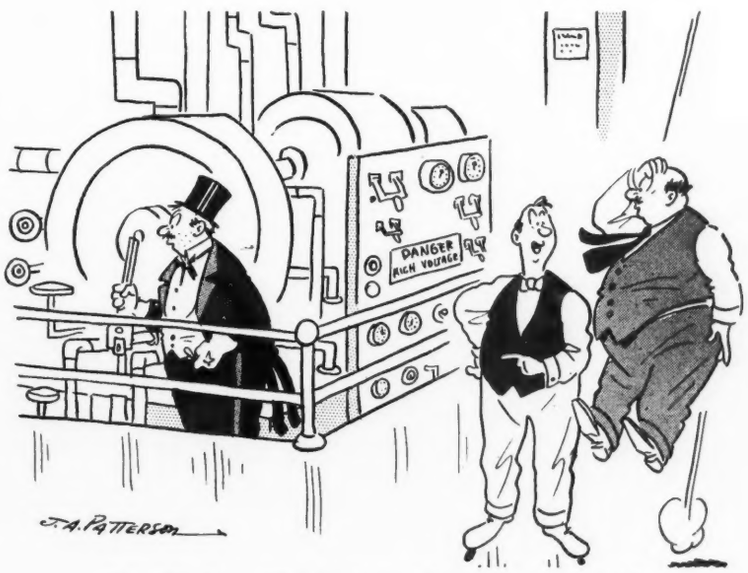


Fig. 3—Flow diagram shows how diesel and steam are combined to make an economical plant arrangement

Operating experience with the modernized plant has been good during the 15 months of its life. The diesel has given no trouble and no work has been done except routine inspection and maintenance. Analysis of five months' operating costs indicates a saving of about $750 over the old plant. This figure does not include maintenance cost, which has been negligible, or fixed charges.

Exhaust Lines

Back in the days when James Watt and Matthew Boulton were pushing sales of Watt's "newfangled" engine, they figured they needed help with the job of erection, since they were selling more engines than Watt could handle personally. In those days "erection" covered a multitude of sins, since most of the engine except the cylinder was built on the spot with local materials and local labor, and the erector had to be a mechanic good enough to handle all the weird complications that such a situation might breed. An early job hunter was a young Scot, William Murdock. Nervous, he kept twirling his hat, until Boulton noticed it; asked what it was made of. "Timmer, sir! I turned it mysel' on a bit lathey of ma oun making," was the Scot's reply, according to Smiles, the biographer. Such a job could only have been done on an oval-turning lathe and a man who could make one was mechanic enough for even an erector's job. Murdock was hired and rapidly became the partner's right-hand man. Lots of men have gotten jobs on the strength of their clothes and appearance; this is probably the only case where the job depended on a wooden hat.



"It's OK, Boss—Westgate's gettin' married after work"

In England, pulverized coal is now being pumped into consumer's bunkers from a bulk-supply company's delivery trucks. The seller guarantees chemical analyses.

Process Plant Conditions Makeup,

A single unit does the entire job—heats, softens and filters makeup water, then deaerates mixture of condensate and filtered makeup

By J D YODER*
and
HENRY MOSSHAMMER†

THE Buffalo Electro-Chemical Co manufactures hydrogen peroxide, extensively used for bleaching. Process steam is used mainly for indirect heating, so condensate is available for boiler feed. The remaining steam is used directly in the process and must not be contaminated with solids. Steam is generated at 180 lb and 50 deg superheat.

Early in 1937 a 40,000-lb-per-hr, water-walled boiler was installed to carry the full steam load. Firing is by pulverized fuel, with provision for oil fuel. Boiler feedwater is treated and deaerated in a Permutit hot-lime-soda water softener.

The water-treating problem, typical of that prevailing in other industrial plants where a substantial amount of condensed steam is returned from the process, is: (1) to protect the boilers from scale and corrosion, (2) to maintain boiler-water conditions which will prevent carryover, and (3) to protect condensate-return lines against corrosion.

Makeup is taken directly from Niagara River, which is frequently high in turbidity and has the following typical analysis:

	ppm
Total hardness as $CaCO_3$	118
Calcium hardness as $CaCO_3$	75
Magnesium hardness as $CaCO_3$	43
Alkalinity to Methyl-orange as $CaCO_3$	86
Free carbon dioxide as CO_2	8
Chlorides as NaCl	18
Sulphates as Na_2SO_4	29
Iron as Fe	0.3
Turbidity	75
Silica	4

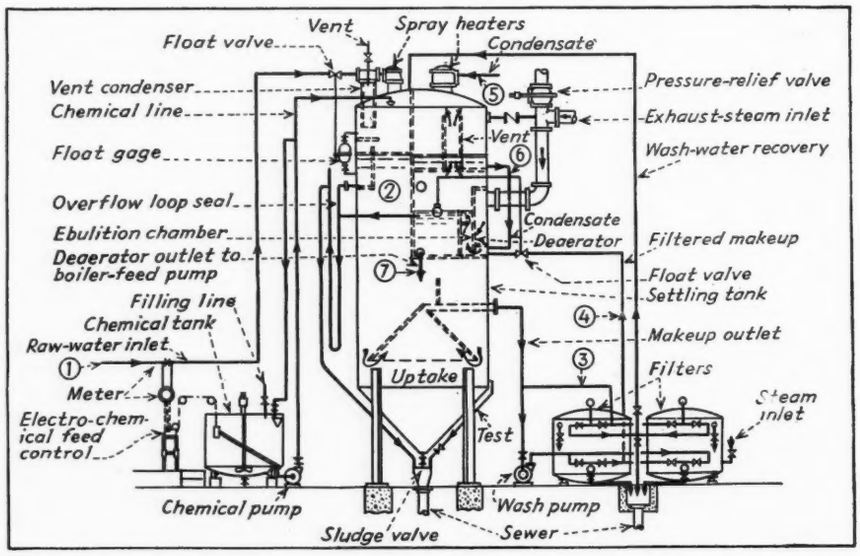


Fig. 1—This unit softens, filters and deaerates (numbers are stations of Table)

The softener selected (Fig. 1) provides for heating, softening and filtering the makeup, and for deaerating the mixture of condensate and filtered makeup, in a single unit, with a single source of steam supply.

Metered Chemical Feed

Raw water passes through a Bailey flowmeter, entering the chemical reaction and settling tanks through an automatically adjustable spray heater which heats the water by spraying it through a steam atmosphere. Whenever a predetermined quantity of water has passed through it, the meter closes an electrical circuit for a fixed period, so that the motor-operated lift pipe in the chemical feed tank is lowered a fixed amount. Thus chemical feed is proportioned to the quantity of makeup water passing the meter. The chemical pump delivers the chemicals to the top of the settling tank. To avoid lime deposits in pump and piping, a substantial quantity of chemical solution is recirculated to the pump suction. The remainder of the pump discharge is delivered to the top of the settling chamber.

Settled water leaving the uptake funnel passes through "Anthrafilt" filters and enters the integral "superdeaerator" built within the settling tank. The condensate enters a separate condensate to the superdeaerator to mix with filtered makeup.

A float valve in the deaerated water-storage compartment admits makeup as required to maintain the desired water level in the deaerator. Ample storage conserves the condensate if it returns for short periods faster than required by the boiler-feed pump.

Entering steam presses the water level down in the steam chest to expose enough perforations to pass the steam required to heat the water. The mixture of preheated condensate and makeup enters the steam scrubber under a weir. To insure thorough scrubbing the steam scrubber is a long and relatively narrow passage.

Oxygen Removal

The table is a record of field tests, showing the degree of deaeration at various stations in the process. Station numbers of the table refer to Fig. 1.

Note that the oxygen in the water at the top of the settling tank (Station 2) and that directly ahead of the filter (Station 3) are about equal (0.22 to 0.33 cc per liter); also that the oxygen is consistently reduced in passing through the filter (Station 4, 0.09 to 0.12 cc per liter), a reduction commonly observed in such plants. This probably results from the mechanical action of filtering out the oxygen with

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Condensate

the precipitate which has been made insoluble by heating the water, but which has not been subjected to the scrubbing action of the steam.

Complete deaeration requires heating the water to exact steam temperature plus vigorous scrubbing with an abundance of steam. The temperature of the deaerated water is regularly as high as the temperature of the steam above the water level.

Routine samples of softened water are taken from the outlet of the filter at 2-hr intervals. Fig. 3 illustrates the test readings for Feb. 22. These curves show that, even though the rate of delivering makeup water to the softener fluctuated on that day (Fig. 2) the hardness is regularly reduced to 18 or 20 ppm with an excess of sodium carbonate of 20 to 25 ppm.

Steam Load

The steam load at this plant is fairly uniform, fluctuations in rate of raw-water flow being caused by variations in the rate of condensate return. Condensate-return lines are protected against corrosion by removing all oxygen from the feedwater and by delivering a relatively small excess of sodium carbonate to the boiler to prevent excessive CO_2 in the steam.

Even though a large volume of steam rushes through the deaerator, it is noiseless in its operation, with no indication of waterhammer. This is possible because (a) The water entering the deaerator is so hot that very little steam is condensed, and (b) There are no confined steam spaces where a vacuum might form.

This plant has been operating nearly a year with no boiler-tube scale or corrosion. There has been no indication of active corrosion of condensate return lines.

Test No.	*Station No.*	*Key to Stations*	*Test Method*	*Oxygen, cc per liter*	*Samples Tested, deg F*
1	1	Raw makeup	W	6.10	87
2	2	Heated makeup	S-G	0.22	87
3	2	Heated makeup	S-G	0.29	88
4	3	Settled makeup	S-G	0.22	88
5	3	Settled makeup	S-G	Spoiled sample	..
6	3	Settled makeup	S-G	0.32	78
7	3	Settled makeup	S-G	0.33	78
8	4	Filtered makeup	W	0.10	87
9	4	Filtered makeup	S-G	0.10	88
10	4	Filtered makeup	S-G	0.09	88
11	4	Filtered makeup	S-G	0.12	78
12	4	Filtered makeup	S-G	0.11	78
13	5	Returned condensate	W	1.40	78
14	5	Returned condensate	W	1.40	78
15	6	Heated condensate	S-G	0.10	72
16	6	Heated condensate	S-G	0.11	72
17	6	Heated condensate	S-G	0.12	72
18	7	Deaerated water	W	No color	87
19	7	Deaerated water	S-G	0.00	88
20	7	Deaerated water	S-G	0.00	88
21	7	Deaerated water	S-G	0.00	88
22	7	Deaerated water	S-G	0.01	88
23	7	Deaerated water	S-G	0.00	78

W — Standard Winkler Test
S-G — Schwartz and Gurney modification of Winkler Test — Method B

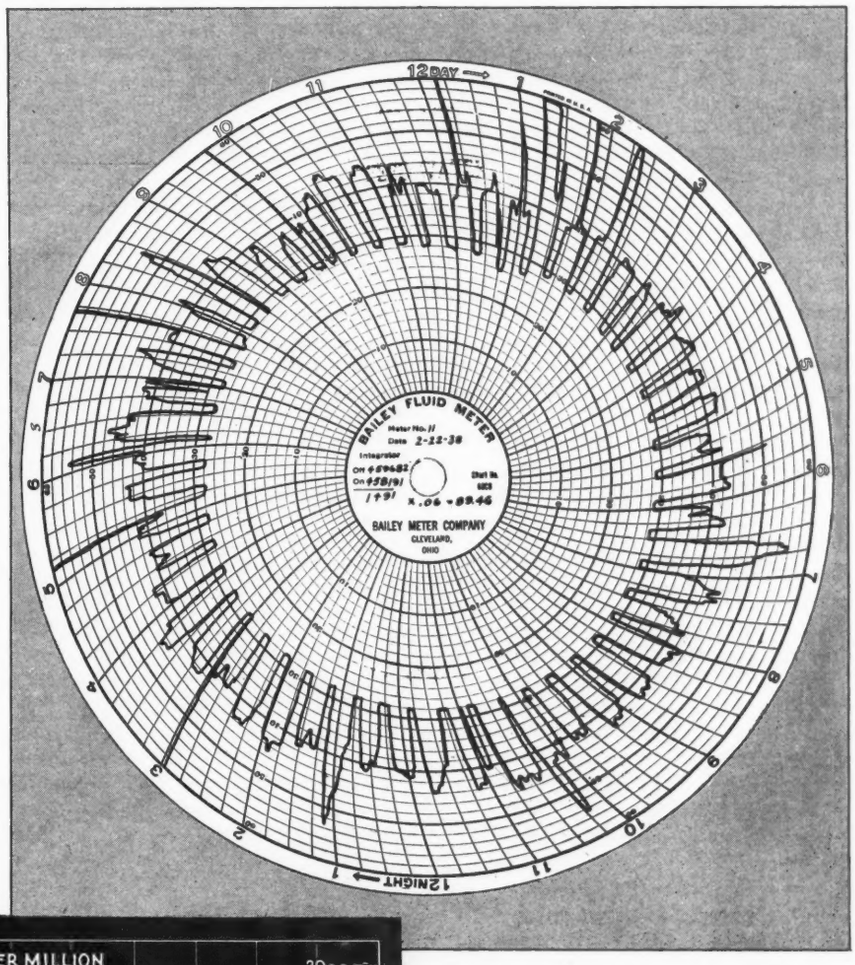


Fig. 2—Note fluctuations of water delivery to softener, although hardness is regularly reduced to 18 or 20 ppm

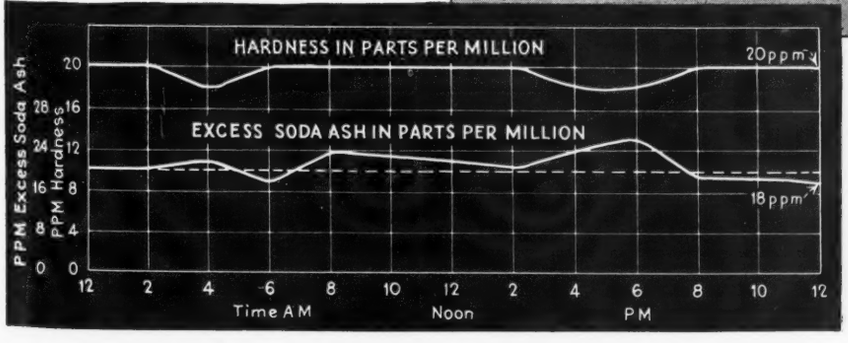


Fig. 3—Daily log of hardness and excess soda ash. Samples were taken from the filter outlet at 2-hr intervals

Fire-Safe Air Conditioning

Ever consider what a fire in your air-conditioning system might do? Recent experience shows sound design and proper maintenance go a long way toward eliminating hazards

RECENT fires involving air-conditioning systems have focussed attention on a double hazard: fire in the system itself, and spreading fires starting outside the system. Analysis of causes shows that simple design changes and wide-awake operation materially reduce these hazards. Let's take a look at some of the possible trouble spots and see what design features should be incorporated in a new conditioning plant, what simple improvements will protect an existing installation, and what operating steps should be taken to reduce fire hazards.

Where ventilating or air-conditioning ducts distribute air to more than one inclosure, experience has shown that a fire starting in one part of the building may be carried to other parts with great rapidity. If fire isn't carried, smoke is almost sure to be, with possible damage to merchandise and equipment in industrial and commercial buildings, and danger of panic in places of public assembly. Possibilities of trouble are greatest with fans running, but natural draft of vertical ducts is often sufficient to carry flame or smoke for considerable distances.

Fires within the building, picked up by return ducts, aren't the whole story; flame or smoke from fires outside the building may be carried in through fresh-air intakes. Both ends of the system must be protected.

Ducts that pass through firewalls, fire partitions, or floors of fireproof or semi-fireproof construction tend to nullify precautions against fire spreading. The National Board of Fire Underwriters makes certain recommendations in "Regulations for the Installation of Air-Conditioning, Warm-Air-Heating, Air-Cooling, and Ventilating Systems." First, where ducts pass through ordinary floors, walls, or partitions, the space around the duct must be sealed with non-combustible material to prevent passage of flame and smoke. Vertical ducts passing through floors of fireproof or semi-fireproof construction are to be encased in 4-in. hollow tile or the equivalent.

Fire doors and dampers help solve the fire-spreading problem in horizontal ducts. In general, ducts should not pass through firewalls. When it is necessary, fire doors, operating on a fusible link, should be installed on either side of the wall. Suggested designs are shown in Figs. 1 and 2. When ducts pass through fire partitions, dampers are required.

A new Underwriter's regulation requires that when vertical ducts pass through floors, fire dampers shall be installed at each outlet, inlet, and branch opening in such duct. Where ducts serve only one floor, only one fire damper shall be required in the main supply duct from the unit and one in the return. The building cross section in Fig. 3 shows the application of some of these principles to a typical air-conditioning installation.

Keep Intakes Clean

Building a bonfire outside a fresh-air intake may sound ridiculous, but it has actually happened. Equally dangerous and more common is ignition of dust and refuse at or near intake. Keeping intakes clean and free of combustibles will eliminate this hazard. Not much can be done about fires on adjoining properties, except to locate intakes carefully and protect them with automatic fire dampers or shutters.

First step in the event of fire in the building is to shut down fans. Minimum requirement is a manually operated shut-off control, accessible in case of fire. Don't be in the shoes of the engineer who had to run from basement to roof of a 10-story building to shut off the fan. Best bet is to have several shut-off stations, strategically situated. In systems using recirculation, a thermostatic shut-off with heat-sensitive element in the return duct ahead of the fresh-air intake will shut down fans if excessive temperature indicates distribution of fire through ducts.

Lack of sensitivity is a weakness of most precautions based on detection by heat; a lot of smoke may be carried through ducts without raising temperature enough to actuate fan shut-offs or fire doors. Photoelectric smoke detection is not yet practical, but more experimenting may soon make smoke detection by this or other means a desirable part of any fire-safe air-conditioning system.

Strong air currents, especially near grilles, may cause trouble with sprinkler operation; that is, the current may blow heat away from the sprinkler head over the fire to sprinkler heads at a distance, where flow is useless. Proposed remedies include tying fan-motor controls to operation of sprinkler system or fire-alarm circuits, so when any sprinkler head lets go, the fan will shut down. Fire experts say this is not quick enough but better than no protection at all.

So much for fires starting outside the conditioning system—let's look at hazards in the system itself. Combustible materials of construction and accumulations of dust and rubbish are the danger points. Wherever possible, non-combustible or fire-resistive lining and insulating materials should be used for ducts, fan rooms, and plenum chambers. Strictly speaking, non-combustible filters don't exist, since a working filter builds up a coating of highly-combustible dust and lint on the entering side. The National Board of Underwriters recommends filters that are sufficiently fire-resistive so that fire spreading over the dust-loaded filter will not be materially fed by burning of the filter itself. Combustible filters are best protected with automatic sprinklers in the filter chamber.

"Cleanliness is next to godliness"—that's the order of the day for fire-safe operation of an air-conditioning system. This means keeping filters

free of excess rubbish and dust either by cleaning or replacement. It also means keeping ducts, fan rooms, and plenum chambers clean and free of combustible materials. Plenum chambers and fan rooms should not be used for storage space.

The care required in handling any oily material applies to viscous filters. Adhesive coatings with flash points above 350 F (Cleveland open-cup tester) reduce hazards considerably. Locate oil tanks for flushing and recharging filters outside the building or in a separate fire-resistive room. Use metal tanks with tightly fitting covers and keep them closed when not in service. Remove sludge from reservoirs of automatic viscous filters.

Ignition Hazards

Supervise carefully any repair work or construction involving welding; several fires have been started by welding torches coming in contact with filter oil and combustible duct lining. Other common ignition hazards are sparks from motors, defective wiring, and air-borne sparks or burning pieces from processes in the conditioned space. An example of the latter is a fire in an air-conditioned printing plant started by a piece of burning waste paper from a type-melting pot, which was sucked into a return duct.

Hotel and restaurant exhaust systems have a special problem—grease fires. Grease in ducts can be cleaned out by burning, if other property is not exposed, and if the Fire Department is notified. Cleanout doors at convenient intervals permit cleaning by scraping and washing, or by use of a non-explosive solvent such as carbon tetrachloride. Steaming is also effective. Fires in greasy exhaust ducts can be fought with hand CO_2 extinguishers, and water from a spray nozzle may be effective. In large installations, sprinklers are recommended, and maximum protection can be had from a CO_2 system, with a battery of cylinders rigged to release fire-smothering gas under control of a thermostat element in the duct.

Enough of the highlights—for further information on hazards and fire-defeating measures get a copy of "Regulations" from the National Board of Fire Underwriters at 85 John Street, New York, N. Y. Remember the operator's responsibility in this matter of fire protection is threefold: to try to get a fire-safe installation in the beginning, to study the existing installation for changes which will reduce fire hazards, and to maintain the plant with these hazards in mind.

Drawings are reproduced by courtesy of the National Board of Fire Underwriters.

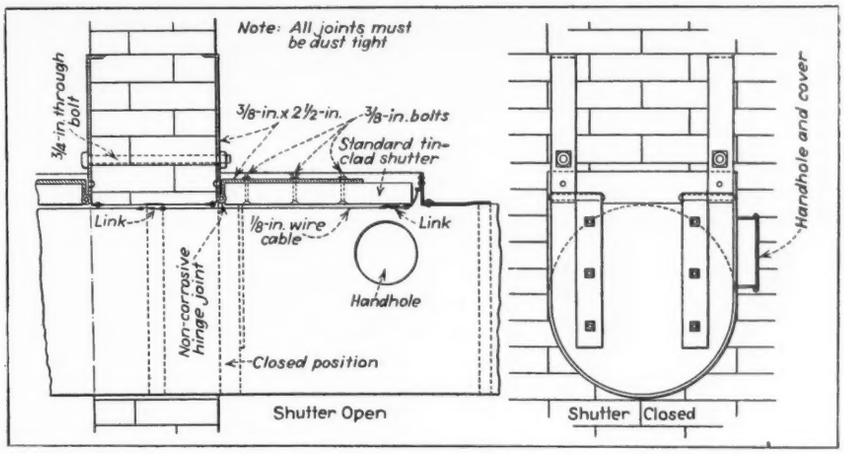


Fig. 1.—Suggested design of hinged fire door for duct passing through fire wall

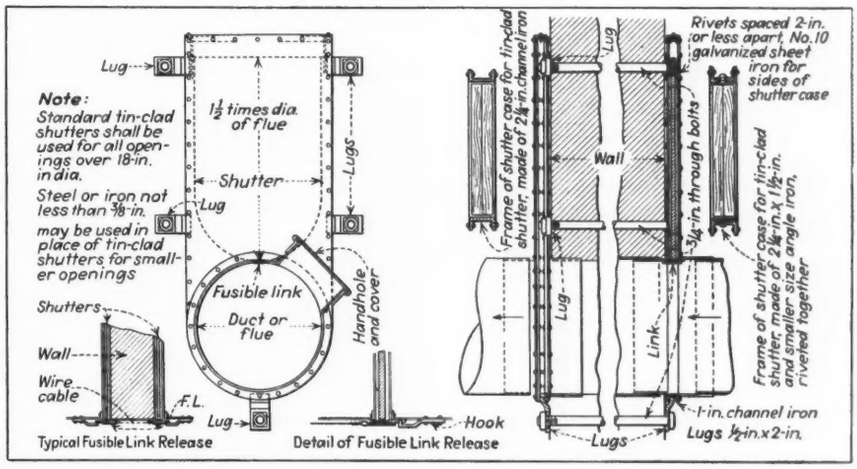

Lug
Note: Standard tin-clad shutters shall be used for all openings over 18-in. in dia. Steel or iron not less than ⅜-in. may be used in place of tin-clad shutters for smaller openings
1½ times dia. of flue
Shutter
Lugs
Lug
Fusible link
Duct or flue
Handhole and cover
Shutters
Wall
Wire cable
F.L.
Lug
Typical Fusible Link Release
Hook
Detail of Fusible Link Release
Frame of shutter case for tin-clad shutter, made of 2¼-in. channel iron
Lug
Rivets spaced 2-in. or less apart, No. 10 galvanized sheet iron for sides of shutter case
Wall
¾-in. through bolts
Frame of shutter case for tin-clad shutter, made of 2¼-in. x ½-in. and smaller size angle iron, riveted together
Lug
Link
Lugs
1-in. channel iron
Lugs ½-in. x 2-in.

Fig. 2.—Suggested design of vertical fire door for duct passing through fire wall

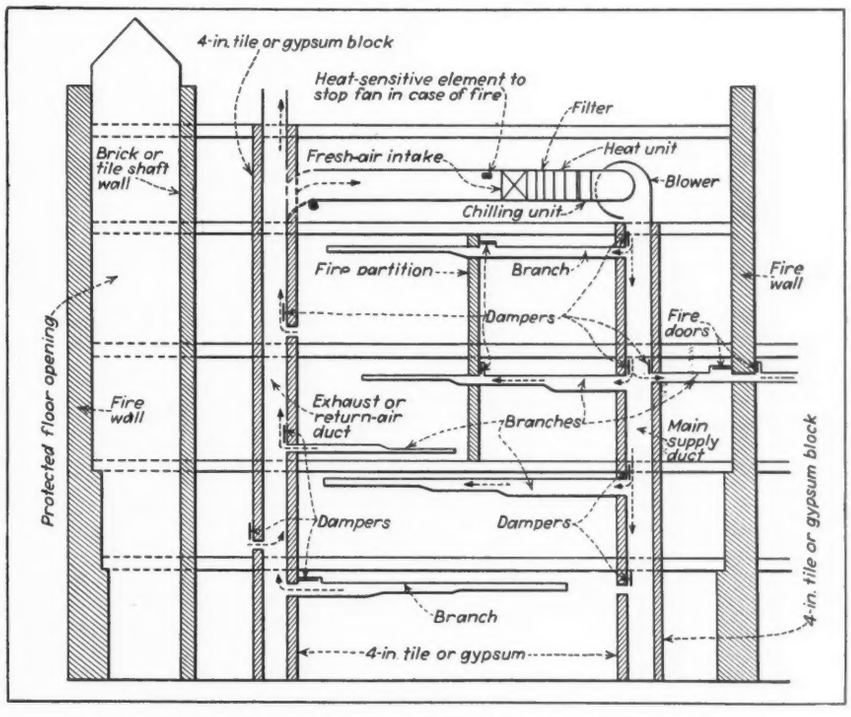


Fig. 3.—Typical installation in building of fireproof or semi-fireproof construction, showing location of fire doors and dampers and application of tile or gypsum block to ducts

Variable-Speed Transmissions

Second of a series of articles on speed as you like it. This one covers multi-speed gears, rollers and disks, tapered rollers with planetary gears, and eccentrics

"SPEED—As You Like It," August *Power,* mentioned a wide variety of devices developed to adjust speed of constant-speed-motor-driven machines. These include both mechanical and hydraulic types. Many have not survived and after a period of use were abandoned for one reason or another. This and two subsequent articles will describe variable-speed transmissions that have endured and are available today.

A multi-speed gear, although not in a strict sense a variable-speed transmission, is an approach to the problem. Driven by a 2-speed motor, the combination becomes equivalent to an adjustable-speed motor with 8-point speed control. Fig. 1 shows a cross section of a multi-speed gear that can be shifted under load. Pinion *P* on the motor shaft meshes with a large gear *G* keyed to hollow countershaft *D,* on which are 4 gears stepped in sizes that mesh with 4 gears keyed to output shaft *O*. Each of the gears on the counter shaft is normally free to rotate on a pair of clutch shoes, kept from turning on the shaft by two expanding wedges, Fig. 2. Inside the countershaft is a forged spring flared at one end and connected to the speed-changing handle at the other end through a rack and pinion.

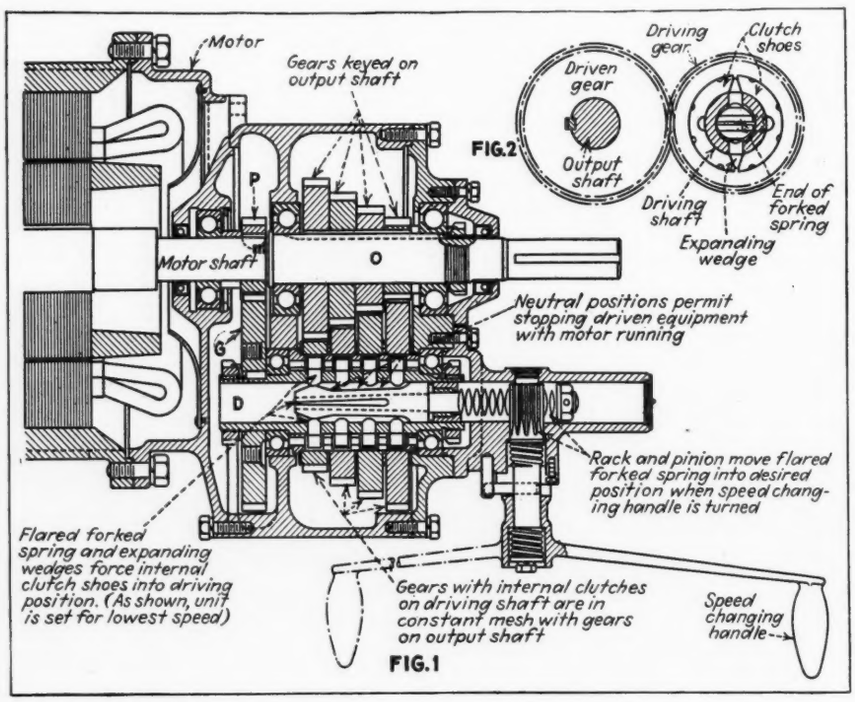
Four Output Speeds

Any one of four different output speeds may be readily obtained by setting the speed-changing handle at the desired position. The end of the forked spring is drawn between the end of the two tapered pins. These expand the clutch segments in one of the gears, causing it to drive its mating gear on the output shaft. For example, in Fig. 1, the flared forked spring is in a position to clutch the left-hand gear on the countershaft. This gear, the smallest on the countershaft, meshes with the largest on the output shaft to give the slowest output speed. As the forked spring is moved to the right, speed is stepped up until highest speed is reached when the right-hand gear is clutched. Driven equipment may be shut down at any time without stopping the motor, by moving the speed-changing handle halfway between any two operating positions.

One of the oldest and simplest devices for adjusting speed infinitely is a roller sliding at an angle of 90 deg. across a disk. Fig. 3 shows a variable-speed transmission built on this principle. *C* is a hardened-steel driving disk on the input shaft and *R* the hardened-steel driven roller on shaft *S,* which is geared to gear *G* on the output shaft. In operation, the power unit drives disk *C,* which in turn by friction drives roller *R* geared through shaft *S* to drive the output shaft. By turning handwheel *H,* roller *R* can be positioned on disk *C*. When the roller contacts the outer edge of disk *C,* output speed is maximum. Moving roller *R* toward the center of disk *C* decreases speed.

In the roller-disk design, contact pressure of driven roller against driving disk is proportional to load on the output shaft. This is accomplished with an automatic loading device on the left, Fig. 3. Disk *A* is keyed to the input shaft and has on its inner surface a ball race. Disk *B* has 4 balls in it that on one side rest in the race in disk *A* and the other side ride against driving disk *C*. In the bottom of the ball race are four equally spaced rises that tend to force disks *A* and *C* apart as the balls try to roll over them. The heavier the load, the greater is the force tending to make the balls ride up on the high spots. Thus, loading between roller *R* and disk *C* increases and decreases as with the load.

The variable-speed transmission, Fig. 4, is essentially a differential-compound-planetary gear train that can be operated to give output speeds varying from desired maximum down to zero and reverse. Two planetary tapered rollers *D* are mounted in ball


Motor
Gears keyed on output shaft
P
Motor shaft
O
G
D
Neutral positions permit stopping driven equipment with motor running
Rack and pinion move flared forked spring into desired position when speed changing handle is turned
Flared forked spring and expanding wedges force internal clutch shoes into driving position. (As shown, unit is set for lowest speed)
Gears with internal clutches on driving shaft are in constant mesh with gears on output shaft
Speed changing handle
FIG.1
Driving gear
Clutch shoes
Driven gear
Output shaft
FIG.2
Driving shaft
End of forked spring
Expanding wedge

Figs. 1 and 2—This multi-speed gear provides 4 fixed speeds with a constant-speed motor

bearings and supported on a carrier *C*. The left-hand end of the carrier is supported on bearing *B* and the other end connects to the input shaft, through a cam *A*. At the left-hand end of the rolls, pinions *F* mesh into gear *G* keyed to output shaft.

A cylindrical ring *E* contacts the planet rollers and serves as the fixed member of the gear train. This ring is moved lengthwise of the transmission to change speed. Cam *A* not only drives the carrier, but also applies an outward pressure to the planet rollers proportional to torque applied to the input shaft. Pressure applied by cam to tapered rollers brings them in driving contact with ring *E*.

Planetary Rollers

In operation, power applied to the input shaft rotates carrier *C* and planet rollers *D*. Planetary rollers, being in driving contact with ring *R*, are rotated to drive the internal gear on the output shaft. When the ring contacts the large end of the planet rollers, their speed will be minimum for a given input speed and maximum when the ring contacts their small ends.

Output-shaft speed is a resultant of the speed at which the carrier rotates and that of the rollers. As ring *E* is moved from the large end of the roller to the small end, output-shaft speed varies from a maximum of approximately 33% of input speed down to zero and reverse. Higher or lower maximum output speeds can be readily obtained by supplementary gearing built into transmission output end.

In this transmission, amount of tractional pressure between planet rollers and ring is at all times proportional to load demand, but without excessive loading on the bearings. This loading is derived from cam *A* and is automatically responsive to external load and speed ratio. Rollers are so supported that leverage of

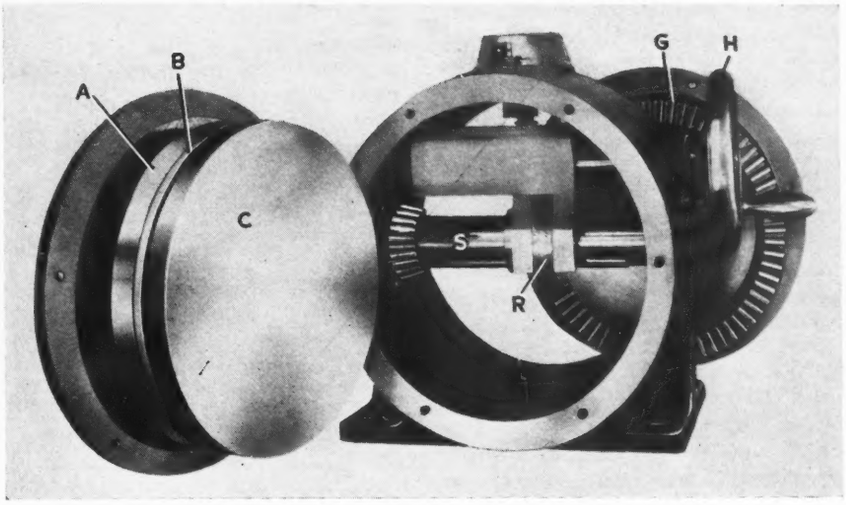


Fig. 3—An adjustable roller in contact with a rotating disk gives infinitely variable speed range of 3 to 1

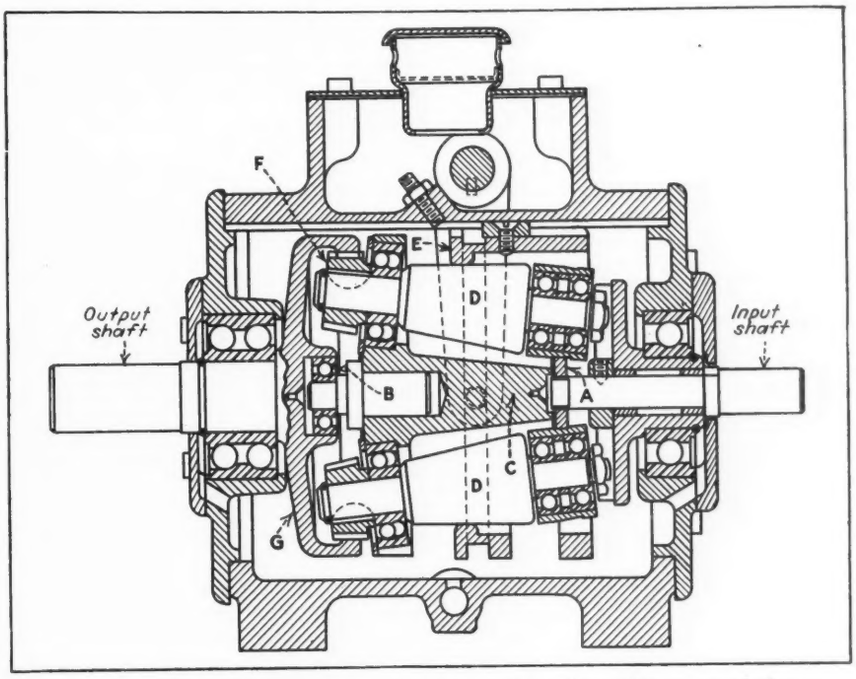
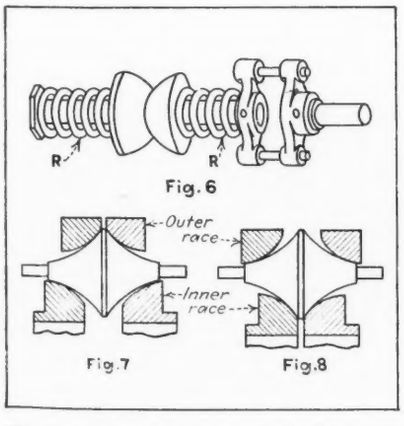


Fig. 4—With tapered rolls and internal gearing this transmission can adjust speed down to zero and reverse



Figs. 6, 7 and 8—Input shaft, inner and outer races of Fig. 5

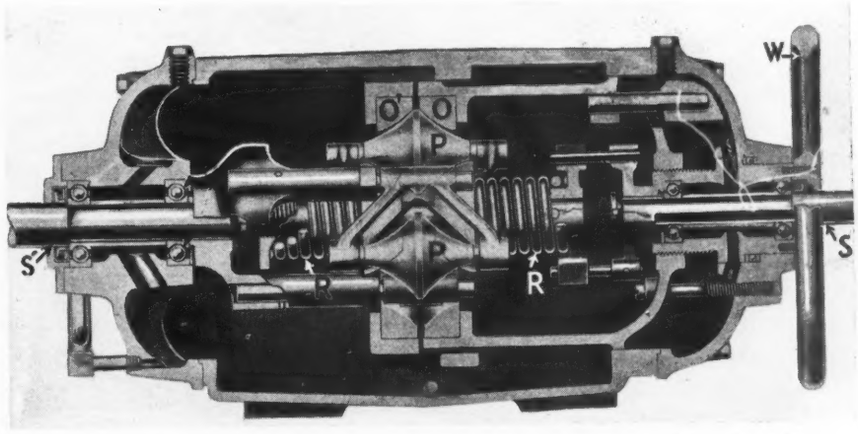


Fig. 5—This variable-speed transmission operates on the principle of a variable-ratio planetary gear, but uses conical rollers

pressure applied at the cam increases automatically as the ring is moved to the small end of the rollers. This is as it should be, since for a given horsepower capacity, output torque increases with speed reduction.

Fig. 5 shows a transmission that operates on the principle of a variable-ratio planetary gear and uses conical-shaped rollers instead of gears. *S* is the constant-speed and *S'* the variable-speed shaft. On the input shaft is mounted the inner race for conical rollers *P*. The two halves of this race are prevented from turning on the shaft by a spline key and are forced together by spiral springs *R*, Figs. 5 and 6. Attached to the output shaft are three planetary rollers *P*, two of which can be seen in Fig. 5. Springs *R* on the input shaft force the inner race against the planetary rollers and press them out into the outer race *O*. This outer race is adjusted by control wheel *W*, which is attached to the right-hand side of the race.

Driving the input shaft turns the inner race. This in turn drives the planetary rolls in the outer race to power the output shaft. When the outer race is closed, as in Fig. 7, the inner race is riding on the smallest diameter of the planetary rollers and all revolve at a maximum speed for a given input shaft speed. Separating the races to a maximum position, Fig. 8, causes the inner race to ride on the largest diameter of the planetary rollers and the outer race on the smallest diameter of these rollers. This position produces a minimum speed of the planetary rollers and the output shaft.

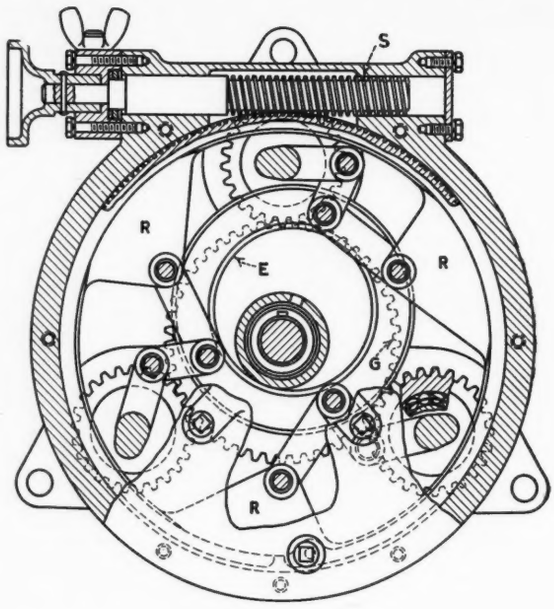


Fig. 9—Variable-speed transmission for regulating speed of feeder and other conveyors; speed control is by eccentric, linkages and gears

The variable - speed transmission, Fig. 9, has been developed for regulating speed of feeders and other conveyors. Eccentric *E* is on the input shaft and gear *G* on the output shaft. Three small gears meshing into gear *G* are fixed in position and each is mounted on a free-wheeling clutch.

These clutches engage when they are rotated counter-clockwise and release when rotated clockwise. Shafts of these clutches connect through a linkage to adjusting ring *R*.

As eccentric *E* rotates, it pushes the linkages outward, and, in so doing, turns each small gear through a small arc, thereby rotating output gear *G*. When the cam passes a linkage, it is released by the clutch and returns to the center ready to be pushed out on the next revolution of the cam. Thus the output shaft is rotated by a series of overlapping impulses that give a fairly constant angular velocity to the output shaft.

Output speed is adjusted by rotating ring *R* through a small arc by screw *S*, which lengthens or shortens the linkages to decrease or increase throw of the clutches. Speed adjustment is made by the wheel *H*, Fig. 9, an indicator being provided to show output speed for any adjustment made with the handwheel.

For assistance in preparation of this article, *Power* is indebted to Westinghouse Electric & Mfg Co; Lenney Machine & Mfg Co; Graham Transmissions, Inc; Stephens-Adamson Mfg Co; Columbia Vari-Speed Co; and Morse Chain Co.

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When American Manufacturers Were Swindlers

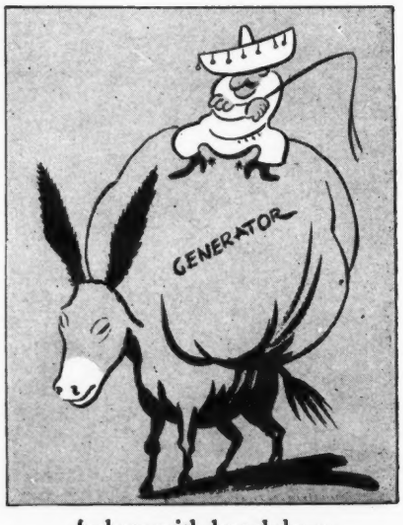
By N L REA*

ERECTING ENGINEERS must, of course, do their own work on foreign assignments. Further, they must serve as general agents in promoting prestige of all kinds of equipment shipped abroad by American manufacturers. The extent of this work is illustrated by a typical job in "back-of-beyond."

The customer was two days by rail and three by "muleback" from tidewater. General Electric had shipped a small generator and a direct-connected exciter, completely knocked down for "jackass" transportation. In addition, there were distribution transformers, house-wiring material and street lights. The purchaser claimed he had skilled men who could handle installation.

Some months later, a letter announced that equipment had been assembled by very competent men, but that it would not generate. The customer's electrician thought that the residual magnetism had been lost in crossing the equator. "Please send another generator and a man to make it generate," was his demand.

The erecting engineer sent to take care of this delicate situation was greeted with the statement that his firm had shipped defective and inferior goods, as was customary with all American firms. What was more, all American manufacturers were swindlers! A general denial was entered, and the erecting engineer stated that



Jackass with knockdown

* Contract Service Department, General Electric Co, Schenectady, N. Y.

as soon as the electrical equipment was working he would look into the other complaints.

In checking the electrical installation, the erecting engineer found that:

1. The stator punchings had been assembled by the handful, instead of one at a time, with no attention paid to lining up the slots.

2. Stator coils had been driven into the slots with a hammer. If a slot was too narrow to take the coil, insulation had been peeled off with a knife.

3. Series connections had been made by joining as many coil ends together as could be comfortably held in one hand.

4. Pole-leads phase connections had been put on wherever there was a loose end.

5. One of the external cables of the generator leads had been cut off, because the man in charge of the work said that no machine should have more than two leads.

6. Generator connections had been made by connecting one external lead of the generator to one side of the exciter armature. The other side of the exciter armature was connected to one side of the shunt-field circuit, which, in turn, was connected to the remaining wire of the 2-wire transmission line.

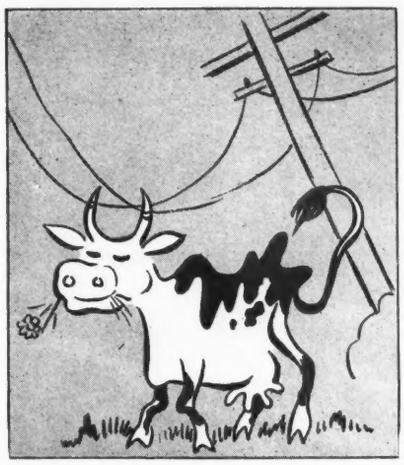
At the bull fight

7. Terminals on each side of each shunt field were connected together, as well as to the adjacent coil.

8. The 2200-volt sides of the distribution transformers had been connected to the house circuits; the 110-volt sides to the transmission line.

9. The small, 2-kw exciter armature had been shipped with a 2- or 3-ton press fit. This arrangement was unheard of. So, the shaft and bore had been filed to allow the armature to be shoved on the shaft by hand. Then, the armature would promptly walk out from under the exciter field when the machine was run.

The engineer realized that a demonstration was necessary to restore confidence of the customer and the public in this town of 5000 inhabitants. He therefore secured the exciter armature on the shaft and made temporary connections so the exciter would light a number of lamps at strategic points in the plant and in the town. These were turned on the second night after the engineer's arrival. The customer's attitude changed immediately, and he consented to restacking the core, ordering new coils and general overhauling of the distribution system.



Cowhorns as insulators

A little later, the system went into operation, supplying about 1000 lights —revenue being sufficient to pay for the complete installation in approximately two years. As a result, units for neighboring towns were ordered.

Public opinion had changed to such an extent that a bull fight was given in honor of the erecting engineer. For the event, spectators chose various vantage-points—on roofs, in windows, and in trees. The Governor-General, dressed in full regalia (uniform, gold lace, ostrich plumes, sword, dagger, revolver) and the guest of honor were to stand on the sidewalk. When the bull charged in their direction, they were supposed to be the last ones to seek shelter inside a nearby building.

During the proceedings, the bull suddenly swerved and came in their direction sooner than was expected! There was no time for a dignified exit. In the scramble the Governor-General and the erecting engineer became wedged in the doorway and fell over one another with a great clatter of swords, daggers, and miscellaneous artillery, but a split second before the bull got to them, some of the spectators slammed the heavy doors.

With the electric equipment in operation and the bull fight behind him, our engineer took time for a general survey of the locality. Glass and porcelain-line insulators were rather scarce in that section of the country. Consequently, the telephone company used sections of cow horns for insulators. Some of these were used with success in the secondary distribution system.

He also found that there was considerable American machinery in that section which had been ordered and delivered, but, for various reasons, never installed. In some cases, the wrong materials had been ordered. In others, the man who had ordered the material had died and neglected to inform anyone what he had ordered or what the material was for. Often the material had been improperly installed.

One large plantation had a steam engine and boiler for driving a sugar mill. The furnace under the boiler had never been bricked-in. The belt from the steam engine to the line-shafting was made from sun-dried cowhides, with the hair still on. There wasn't enough cowhide by 6 ft, and the gap had to be bridged with rawhide thongs. As the belt stretched, thongs were occasionally pulled up. When a load of approximately 25% of the engine's rating was thrown on, this gap in the belt would hang up on the pulleys, which called for two "peons" to pull on the belt and start things moving again.

Bricking-in the furnace and installing a regular belt produced more power than was required. The customer expressed much surprise that the machine actually worked.

Our engineer also had a look at a threshing-machine that had never worked because the stationary fingers that should mesh with the revolving cylinder were bolted on upside-down, with the teeth sticking up in the air.

There were a large number of similar cases straightened out by the erecting engineer, so that he left behind him many friends and the conviction that Americans and American goods were all right after all.

Americans OK after all

Short Cut to Steam Rate

Graphical method makes it easy to find average steam rate if average load is known

By GLENN C BOYER
Associate Engineer, Burns & McDonnell Engrg Co

RAPID FIGURING of average steam rate for turbines running at varying loads looks complicated, but a short-cut graphical method can be applied if the principle of Willans Line is remembered. Use of the method outlined here greatly simplifies comparative-performance studies of single-valve turbines.

Plotting total throttle flow of steam in a single-valve turbine (straight condensing or non-condensing) against load produces a line that is straight, for all practical purposes, from full load down to about 15% of full load. This is known as the Willans Line. Since the line is essentially straight, a point on the curve representing average load on the unit will give average flow of steam; this is true no matter how the load supplied by the turbine varies.

Plotting the Graph

Performance data for a 3000-kw turbine, given in Fig. 1, produces Willans Line No. 1, when plotted as shown. Average load on this unit is 10,000,000÷8760=1140 kw. Reading from the chart, the average steam flow is 13,600 lb per hr. Converting back to lb of steam per kwhr generated, we obtain 13,600÷1140=11.92 lb per kwhr.

Some of the reasoning behind this process is evident if it is remembered that steam admitted to the turbine is required for (1) windage, friction, and other machine losses, which remain essentially constant at all loads, and (2) production of electrical energy, which varies directly with load. Referring to the same 3000 kw turbine (Fig. 1), it can be seen that the first 1500 kw required 16,950 lb while the second 1500 kw needed only 31,260 —16,950=14,310 lb. Assuming losses to remain constant, this 14,310 lb all went to generate power, so the steam rate for power generation is 14,310÷1500=9.54 lb per kwhr. Approximate steam required for windage and friction is 16,950—14,310=2640 lb. Average steam rate for overcoming this loss is 8760x2640÷10,000,000=2.32 lb per kwhr. Total steam rate is 2.32+9.54=11.86 lb per kwhr, which checks within 0.06 lb or 0.5% of the value determined graphically.

Value of this short-cut method lies in its speed of application to everyday problems such as comparing steam requirements of turbine-generating units for a particular installation. To illustrate: Fig. 1 contains the Willans Lines for two additional turbines with different capacities and throttle conditions, both of which were considered for the load conditions previously given. Average steam rates for each are readily obtainable from the chart, as shown.

With simply-made charts such as Fig. 1, comparisons of turbines can be made for estimated future loads as well as known present conditions. All that is needed to get the average steam rate is to know average turbine load for the period under consideration.

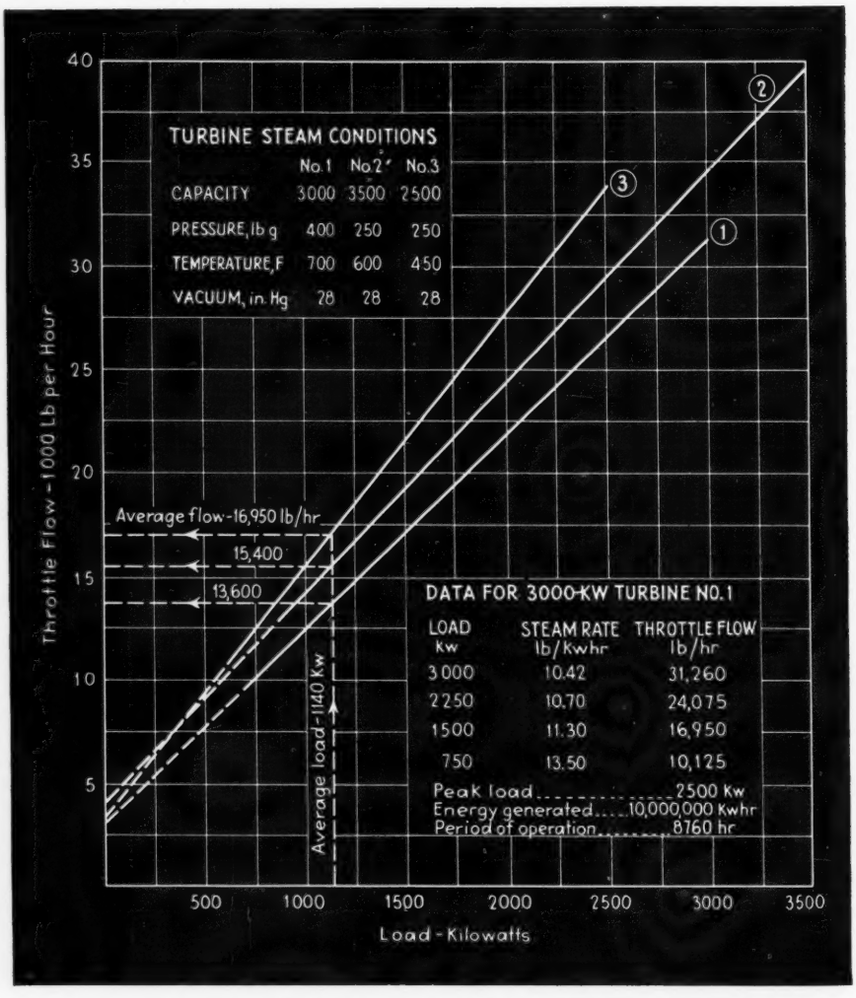
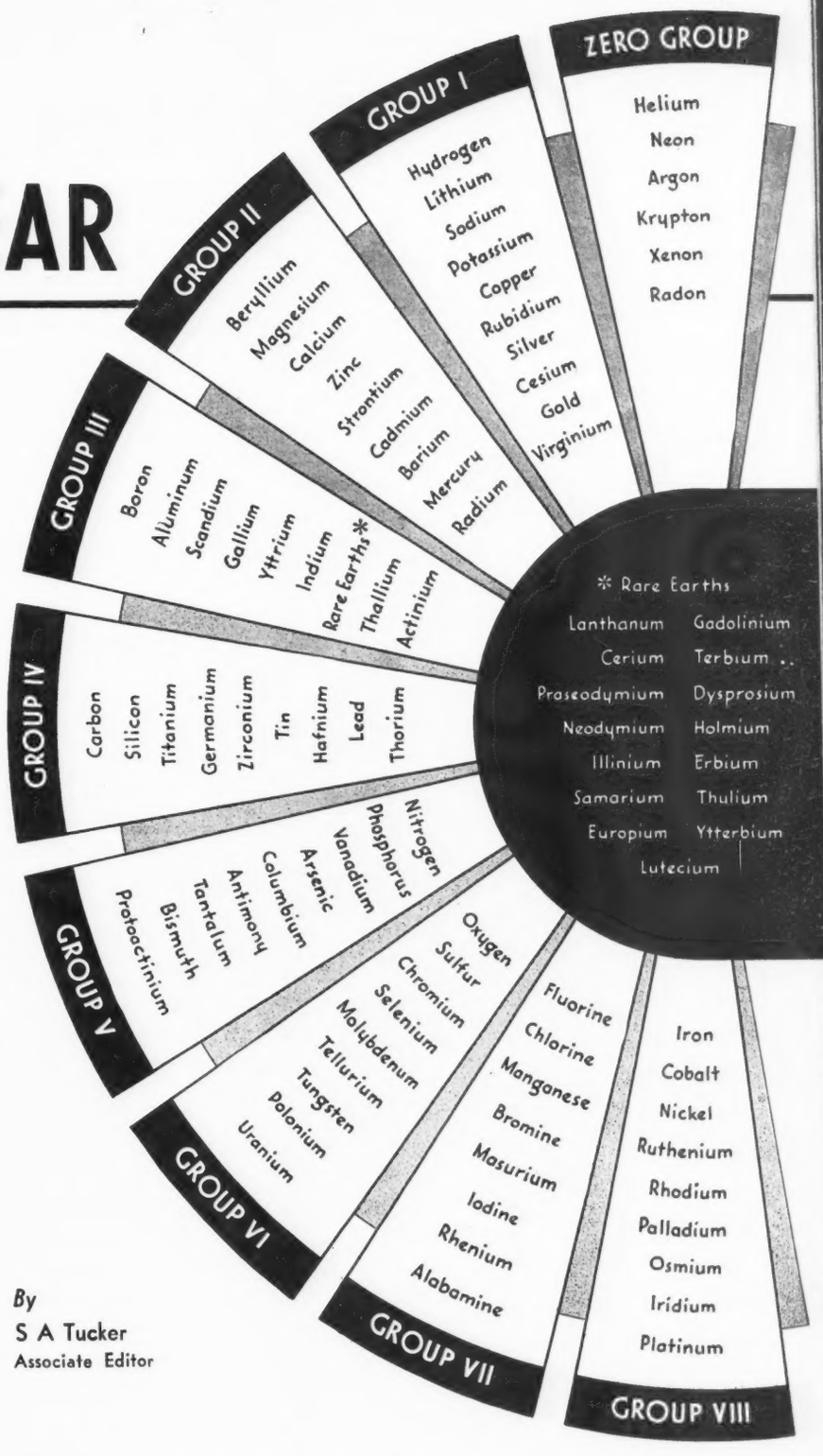

TURBINE STEAM CONDITIONS
No.1 No.2 No.3
CAPACITY 3000 3500 2500
PRESSURE, lb g 400 250 250
TEMPERATURE, F 700 600 450
VACUUM, in. Hg 28 28 28
Throttle Flow - 1000 Lb per Hour
Load - Kilowatts
Average flow - 16,950 lb/hr
15,400
13,600
Average load - 1140 Kw
DATA FOR 3000-KW TURBINE NO. 1
LOAD kw
STEAM RATE lb/Kwhr
THROTTLE FLOW lb/hr
3000 10.42 31,260
2250 10.70 24,075
1500 11.30 16,950
750 13.50 10,125
Peak load ..... 2500 Kw
Energy generated ..... 10,000,000 Kwhr
Period of operation ..... 8760 hr

Fig. 1—Willans Lines for three turbines of different characteristics

WAR on WEAR



By
S A Tucker
Associate Editor

TO CHARLEMAGNE, ruler of France in the Middle Ages, once came envoys from the Emperor of the East, powerful Harun-Al-Rashid. They wanted, so the story goes, to look over the battle power of the French army. After wining and dining the ambassadors, the crafty King roared for pages to remove the bespattered table cloth. As the amazed guests watched the exquisite spread tossed to the flames, their awe at the potentate's extravagance turned to fear at his magic when the asbestos cloth reappeared, uncharred, glistening. Thus was a war averted.

To the discoverer of one of nature's secrets a dozen centuries ago came power because of fear his magic inspired or better weapons he built. The search still goes on, but today it is directed towards finding cheaper materials that do ordinary jobs well or new ones that make yesterday's impossibilities tomorrow's accepted practice.

Chemist and metallurgist start with the periodic table of 92 elements listed on this page. The last of these was discovered only seven years ago. Even now, some have not been isolated and their properties measured. Chemists say the list now contains all the elements of the earth's crust and that new materials can be developed only by combinations of them different from those already known.

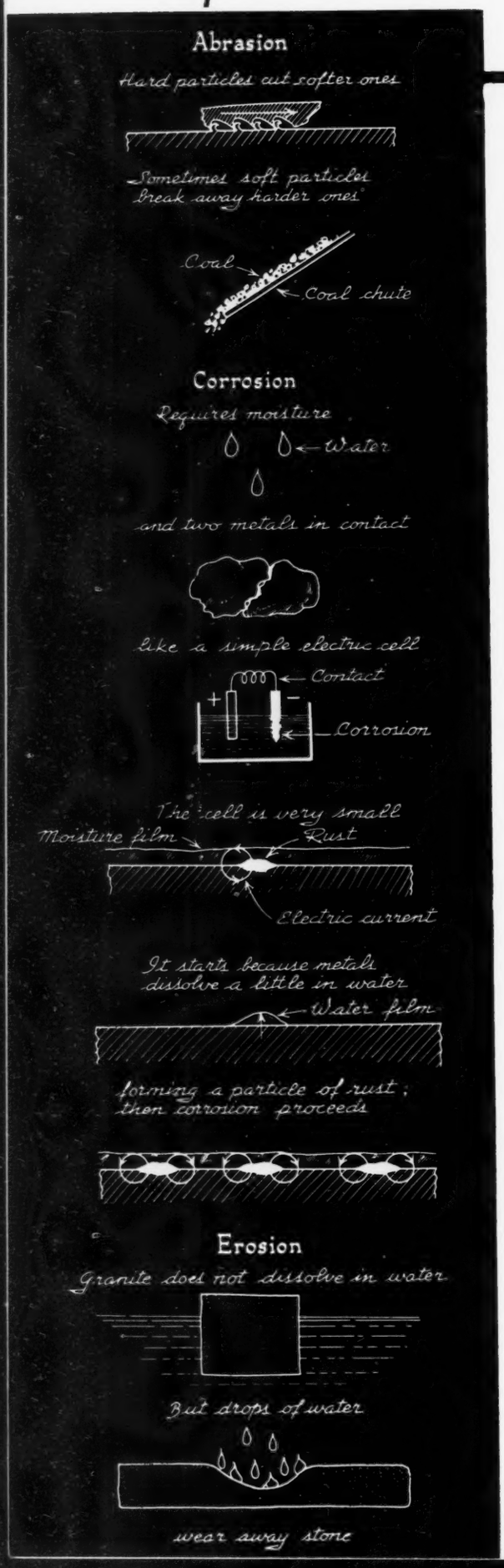
How does this vast amount of research affect the ordinary engineer faced with practical, if complex, problems of everyday wear and tear? There seems a wide gap between long-time creep-stress tests and replacing a corroded heating-system return. But practical uses of a new material are often a nearly accidental by-product of the original intent. Search for a rubber substitute, more in fear of a shortage of natural gum than in hope of a better product, gave us a material that can laugh at oil, rubber's worst enemy. Within recent memory molybdenum was considered a rare metal; today it is "moly" to the power industry because it can make steel shake hands with high temperature.

The power engineer is closest to corrosion, erosion and abrasion, forms of wear. When something rusts through, breaks, or just disappears, he is the one elected to get things going again. In self protection he must learn to use better materials in the sore spots, taking experience of others as a guide but doing most of his own research by trial and error, checking final results under actual plant conditions.

In this, twenty-first of Power's special sections, is collected information on certain materials to resist corrosive attack and other forms of wear. It aims at the worst headaches around the power plant. It starts by defining what abrasion, corrosion and erosion are, and generally what materials resist them best. Included is a table, a materials roll call, to suggest ideas rather than to recommend any particular substance. Discussion follows of particular equipment problems, materials exposed to atmospheric conditions, sea water, flue gas and so on.

As in previous sections, this does not inform the research engineer or the expert in a given field. It is an eminently practical and concise summary of information, brought together for the man who "has to do something about it."

Abrasion . . . Corrosion . .



WEAR is change through use. It implies a gradual change in the properties of a material that render it unfit, or less fit, for service. When one material rubs against another, cutting or scraping away small particles, it is *abrasion*. If the action is chemical, forming rust or scale at the expense of the original material, the term *corrosion* applies.

When fast-flowing liquid pits or grooves a pipe or pump impeller, it is not exactly abrasion because nothing is present hard enough to cut the material. Nor is it quite the same as corrosion; the material might last indefinitely in still or slowly moving liquid. For this in-between condition *erosion* is the word.

Abrasion is easy to understand. Hard particles of one material cut or chip away bits of a softer material. Silicon-carbide or aluminum-oxide crystals bound together with special forms of glue make grinding wheels. Each hard particle acts as a cutting tool on softer materials, the glue serving only to hold the particles in place. This principle is the basis of some abrasion-resistant alloys (and also non-metallic materials) where hard crystals (too brittle alone) are held together by a softer, more ductile bond.

While abrading action is thus simply explained, complex kinds of wear result from abrasion and have varied remedies. Although the hard material generally suffers less than the softer ones, some loss of hard material does occur. Even grinding wheels wear. Hammers or balls in a coal pulverizer, a great deal harder than the coal itself, gradually grow smaller. Such parts, subject to high impact stresses, must be tough as well as hard. Often a compromise between such factors as abrasion resistance, corrosion resistance and strength at high temperature is necessary.

Sometimes tough, resilient materials like rubber withstand abrasion better than harder materials, particularly handling ash and water mixtures. Two factors are present: first, no matter how hard or sharp the particles, they tend to roll along the rubber surface without cutting it, and second, corrosive effects accompanying the abrasive fluid do not affect the non-metallic rubber.

Principal abrasion in power plants comes from coal, ash, flyash and cinders. Entrained sand in circulating water supply is occasionally a source of trouble.

Corrosion is a far more difficult problem than abrasion. First, it is widespread; in one form or another it finds its way into every corner of the plant. Second, the chemical reactions are too complex to be simply explained or readily analyzed for cause in actual practice. And, third, the number of possible remedies appears numberless; seldom is a corrosion condition completely cured. Deciding what to do in a specific case usually means trying more and more expensive materials until an acceptable economic balance is reached between trouble and expense.

Most common form of corrosion is rusting of iron and steel. Most other metals "rust" too, more or less, but they either form a scale resistant to further attack, like aluminum and copper, or corrode at so slow a rate, like nickel and silver, that thin sections last indefinitely. Corrosion usually is taken to apply to metals only; non-metallic materials behave so differently from metals and from each other that no one tries to apply a general term.

It is a generally accepted theory that ordinary kinds of corrosion not only are chemical but are accompanied by production of small electric currents. Like a simple electric cell, two metals or two parts of one metal in electric contact in the presence of moisture corrode by one of them dissolving in the electrolyte (in this case, impure water). While this is far from an explanation of the complex nature of corrosive action, the likeness to an electric cell helps explain many otherwise apparently peculiar results of corrosion.

. Erosion

Other kinds of corrosion, such as the oxide-scaling of iron and steel near white heat, take place without moisture. So different is this action that it should not be confused with the more usual low-temperature kind. Remember that usual corrosion has to have moisture and that some other chemical agent, oxygen, CO_2, salt, sulphur gas, etc, is always present.

A difference of electrical potential also is necessary. This may come from the presence of two different metals, from the metal itself and its corrosion product or from a greater amount of dissolved gas in one place than in another. Any difference in condition of the metal, or of surrounding air or liquid can produce the necessary electrochemical potential. The expression "rust begets rust" is founded on sound fact, one particle of rust forms the nucleus for more corrosion to continue.

When a metal corrodes, an oxide or "salt" of the metal forms. Iron rust, iron oxide with a considerable amount of chemically combined water (hydrated), weighs nearly twice as much as the iron from which it is formed and occupies a volume about ten times as great.

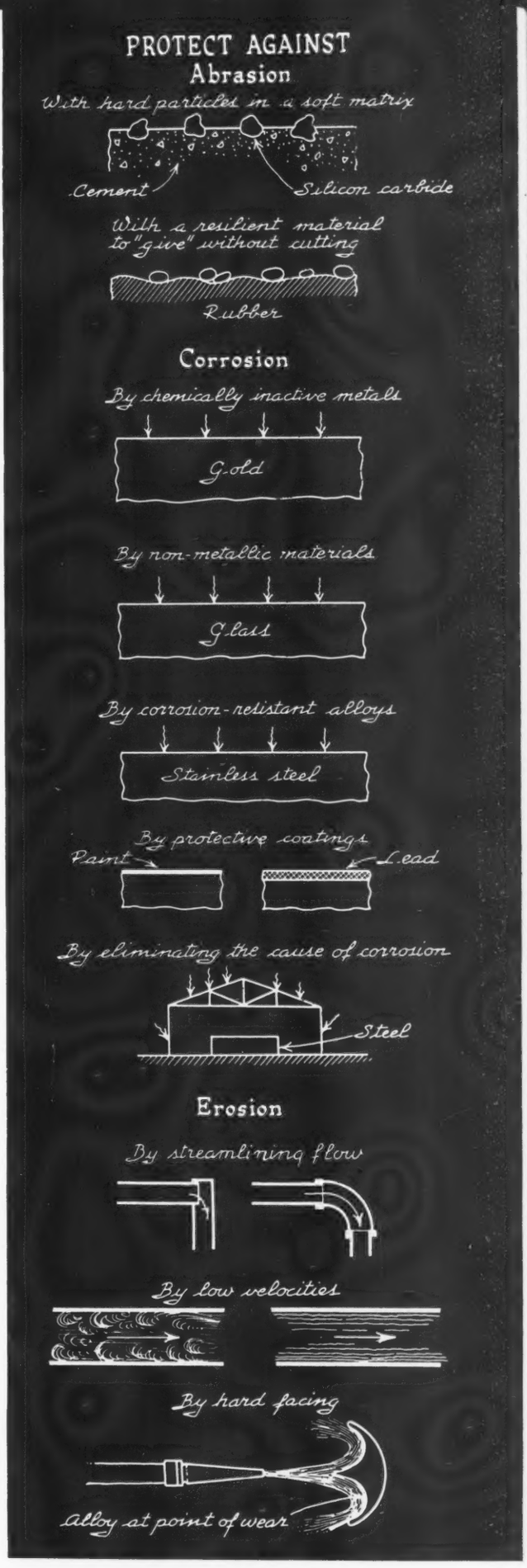
Preventing corrosion is a problem that deserves and gets the attention of every one who has to maintain plant equipment. Millions of dollars are spent each year for paint and coverings alone; more millions are lost for lack of them.

Many technical papers and books have discussed corrosion and corrosion-resistant materials. Many man-hours are being spent in applying the far-from-complete knowledge to specific and troublesome problems. To state the problem and catalog possible solutions is easy; to put the theory in practice requires ingenuity and patience. There are three ways of tackling a corrosion trouble and each is worthy of a book. (1) Use a material, metal, alloy, or non-metallic substance that resists the given corrosive condition. (2) Use a protective coating. (3) Remove the causes of corrosion. Each of these general methods is familiar to all of us by one or another example. Each suits some conditions and is impractical or expensive in others.

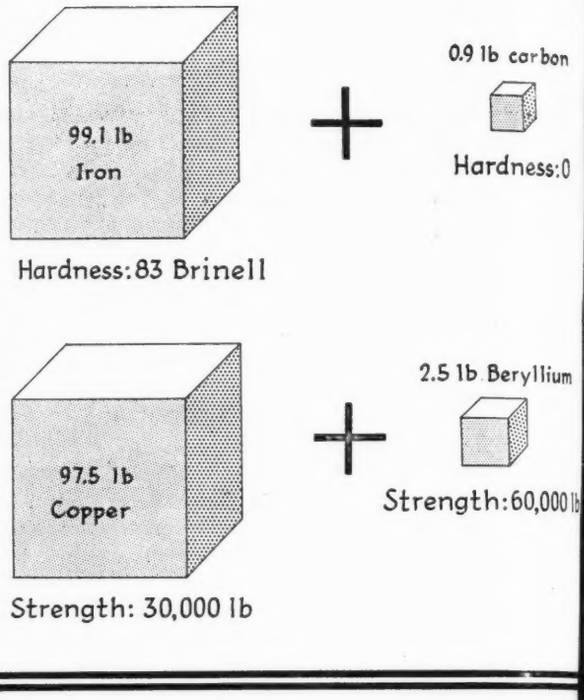
Selection of corrosion-resistant materials requires a knowledge of materials available and their properties. Protective coatings are numerous and are effective in varying degree. The possibility of removing causes of corrosion is often overlooked. In tackling corrosion problems, get familiar with materials that suit the case, experiment on a small scale with an eye on large-scale costs, and be willing to try, try again. Patience and common sense may beat a corrosion problem, not a magic formula.

Erosion might appear at first glance to be the same kind of attack as corrosion. It is nearly always accompanied by corrosion and often confused with the latter. Practice reserves the word erosion to express a wearing action that increases in severity with increase in liquid velocity. The simplest example might be the action of water on granite. Ordinary water does not attack granite measurably so long as the water has no motion. Increase water velocity and localize the point of impact and the stone will gradually be grooved. The greater the water velocity, the more rapid the wear.

Some metals resist corrosion by forming protective scale. Trouble comes when fast-moving liquids wash away protective scale that would be unaffected by still liquid. Avoid erosion by preventive measures if possible. Cure it by changes in design or selection of material. (1) Avoid liquid velocities over 10 fps. (2) Use metals and alloys that resist corrosion without forming scale or that form hard protective scale. (3) Consider resilient coatings such as rubber and special paints.



Metals and Alloys



MOST power-plant equipment is, of course, made of metal. Metals are stronger, tougher and lend themselves to shop-fabricating processes in general better than non-metallic materials. Only a few metals, however, are satisfactory in their commercially pure form; aluminum, copper, nickel and lead are the most usual, valuable for their natural corrosion resistance.

Other metallic materials are alloys, made up of two or more metals or metal-like substances combined in the molten state. A recent publication of the American Society of Metals lists over 8000 alloys, giving their composition, properties and applications. A large proportion of these are useful for power-plant equipment.

New alloys are constantly being developed to (1) produce greater hardness, toughness or corrosion-resistance, (2) combine several properties in a single material, or (3) obtain needed properties more cheaply. They enable manufacturers to turn out a better product or an equal product at a lower price. An operator familiar with available materials can often save maintenance expense by adapting his knowledge to specific plant problems.

An alloy may be (1) a true chemical compound, every molecule like every other molecule but containing two metals (carbon and silicon act like metals), (2) one metal may be "dissolved" in another, or (3) the alloy may be a mechanical mixture with crystals of one metal scattered among those of another, like salt in your sugar.

An alloy may have properties borrowed from one or more of its components, or may have characteristics superior to any of the individual metals. Small percentages of molybdenum, vanadium and tungsten have great effect on the properties of steel.

Iron and its alloys are used in larger quantities than any of the other metals, and it is common practice to classify them as ferrous, or iron-bearing, alloys. Commercially pure iron comes in two forms: "ingot" iron and "wrought" iron, containing filaments of slag. The former is an excellent base for porcelain enamel and other coatings, the latter valuable for its inherent corrosion-resistant characteristics due to the included fibrous slag.

In general, iron alloys intended for casting differ from those to be fabricated by forging, rolling or drawing. Ordinary cast iron is, in fact, an alloy containing carbon and several impurities. Because it is cheap and readily machinable, has moderately good resistance to abrasion and corrosion from water, (sea water and impure water included), more expensive materials are employed only if cast iron is unsatisfactory. Chilled iron (whitish fracture) is cooled quickly in casting and is abrasion-resistant.

Addition of up to 20% nickel with smaller amounts of copper, chromium, manganese and silicon improves heat-resisting and corrosion-resisting qualities of cast iron. With about 14% silicon, cast iron becomes highly resistant to acid attack and is abrasion-resistant, but is not machinable.

Steel is refined pig iron, with impurities and some of the carbon removed. With low-carbon content (¼%) it can be rolled into structural shapes. The great bulk of "carbon steel" is in this class. Increased carbon content up to about 1% results in harder and stronger steel when heat treated.

Many metals are added to steel to form more complex alloys. Nickel, chromium, copper, molybdenum, manganese, tungsten and vanadium are common. These alloys are classified by one or two of the principal alloying agents, but may contain smaller percentages of several others. The properties vary with carbon content and heat treatment as well as with chemical composition.

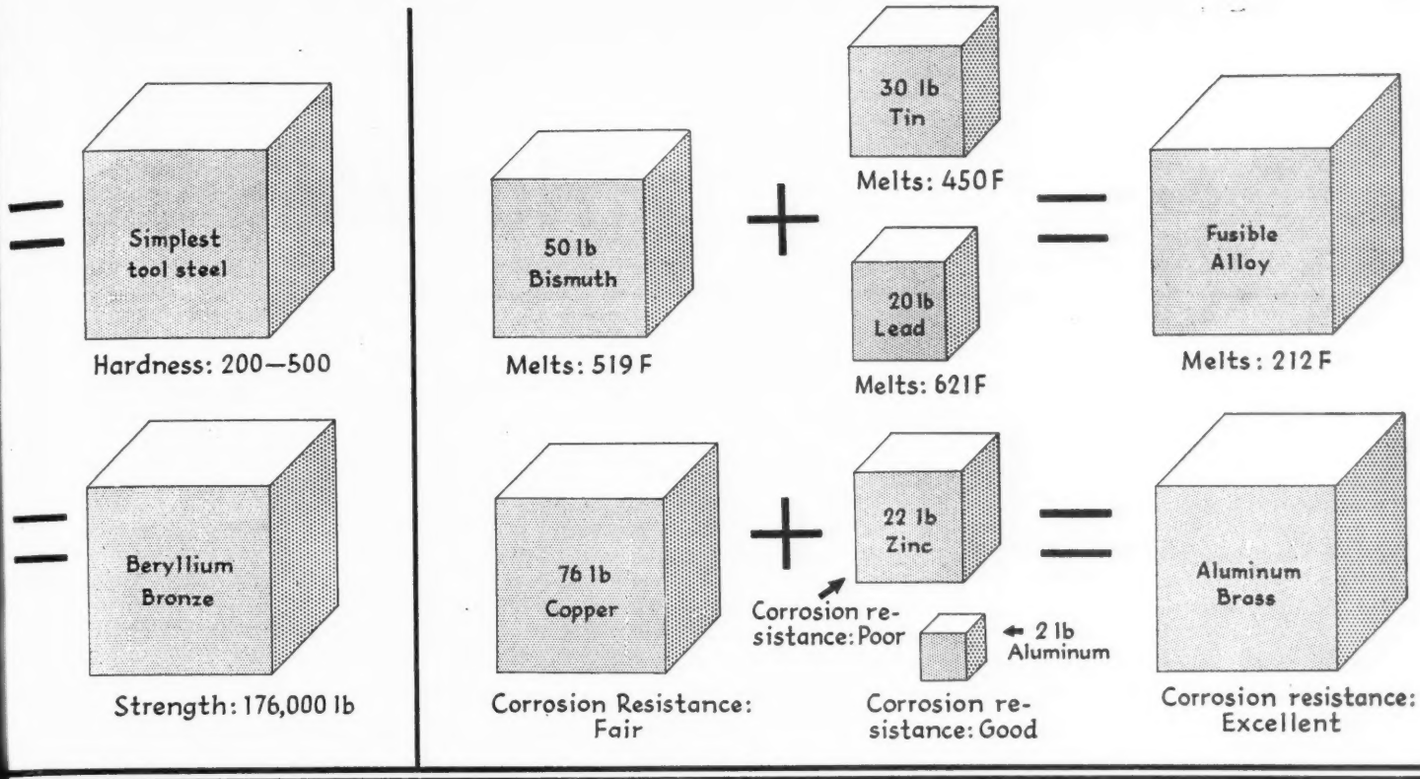
From 4 to 10% chromium increases resistance to scaling at high temperatures and general corrosion resistance. Alloys containing chromium are generally low-carbon steels and contain molybdenum, silicon, manganese and tungsten in small amounts. A large number of low-carbon stainless steels, up to 16% chromium, are marketed under various trade names. High-carbon stainless steels, chromium 10-18%, are notable for hardness and resistance to abrasion combined with a considerable degree of resistance to atmospheric corrosion and chemical attack. Higher chromium content, 25-30%, imparts maximum resistance to oxidation at high temperature.

Nickel up to 6% gives toughness, strength and a degree of corrosion resistance to steel. More common, however, are the stainless steels containing both chromium and nickel in the approximate proportions of 18% and 8%.

Manganese (½% or less) is added to most steels during manufacture to improve structure and combine with sulphur impurities; 15% manganese steel cannot be machined or drilled but has great wear and abrasion resistance for crusher jaws. Tungsten combines with carbon in steel to form hard, brittle carbide for tool steels. Tungsten, chromium, and vanadium are essential ingredients of high-speed-tool steels. Molybdenum (½%) increases creep strength at high temperature and is considered by some more effective than tungsten for heat-treated parts.

Aluminum weighs only one-third as

ALLOYING DEVELOPS SPECIAL PROPERTIES



much as iron, is strong in proportion to its weight and resists corrosion by forming a thin, hard scale to protect the metal against further attack from atmospheric or mild corrosive conditions. Aluminum castings contain up to 8% copper as a hardening agent. Silicon improves casting qualities. Manganese, chromium and magnesium aid corrosion resistance.

Antimony hardens anti-friction and bearing metals for heavy-duty service. **Arsenic** hardens copper; increases its tensile strength. **Beryllium,** 2½%, added to copper, produces an alloy of high-tensile strength when heat treated. It is serviceable for springs subject to corrosion and has the quality of non-sparking for tools used in an explosive atmosphere.

Bismuth, alloyed with lead, tin and cadmium, forms low-melting-point alloys for fusible plugs that melt at temperatures as low as 150 F. Alloys are available that will melt within a few degrees of any specified temperature up to 350 F. **Cadmium** resists atmospheric corrosion as a plating or metal spray. **Chromium** lends corrosion-resistant properties to steel. As plating it is not only resistant to atmospheric corrosion but is very hard.

Cobalt with chromium and tungsten or molybdenum makes high-speed cutting tools and hard facing alloys, abrasion resistant. **Copper** is reasonably resistant to sea water and atmospheric corrosion. Under these conditions it forms a hard green scale, protective under mild corrosion but easily washed or scraped away.

When hardened with zinc, copper alloys are brasses; when the hardening agent is tin, aluminum, silicon, manganese, beryllium or phosphorous the alloys are bronzes. Both vary widely in hardness and corrosion resistance. With 20% and 30% nickel, strong alloys form with a high degree of corrosion resistance.

Lead, in commercially pure form, is particularly suited to withstanding acid attack and moist flue gas at temperatures below 400 F. It can be applied as metal spray or as a lining bonded to steel. **Magnesium** is the lightest of useful metals, weighing only two-thirds as much as aluminum. With aluminum and small amounts of manganese and copper, it forms light alloys with special corrosion-resisting properties.

Manganese is added in small proportions to steel as a deoxidizer. Larger percentages increase shock resistance and toughness and the alloys are abrasion resistant. **Mercury** is the only metal liquid at ordinary temperatures. Its temperature expansion is utilized in thermometers and its quality of being the heaviest liquid, in vacuum columns. The high temperature at which it boils makes possible the mercury cycle of power generation.

Molybdenum and copper in small amounts greatly improve the resistance of steel to atmospheric corrosion. About ½% of molybdenum increases strength of high-temperature steam piping and valve bodies. A small amount is also present in many complex steel alloys. **Nickel** does not tarnish in air, hence nickel plating of small parts for appearance. With or without chromium, it imparts corrosion resistance to steel, adds to strength and toughness.

Tantalum has a low coefficient of expansion and can therefore be sealed into glass. **Tin** alloys with copper to form bronzes and with lead for low-melting-point solders. **Tungsten** is an essential element of many tool steels, and is present in many other alloy steels, to which it contributes hardness. It has a very high melting point and is therefore employed for filaments for incandescent lamps.

Vanadium in very small amounts (0.1%) improves the quality of steel by deoxidizing and avoiding blowholes. It is present in many of the complex steel alloys, adding to shock resistance and toughness. **Zinc,** in addition to forming brasses with copper, is widely used as a coating resistant to atmospheric corrosion. As galvanizing, it protects steel by being corroded itself in preference to the steel.

Non-Metallic

MOST METALS are refined from metallic ores (chemical compounds of the metal), and the finished product tends to return to its combined state like water seeking the lowest possible level. Non-metallics do not corrode in the usual sense of the word because they are generally in a chemically stable condition. Synthetic compounds, extremely complex, have characteristics that can be partly controlled by the chemist.

Paints to withstand 1000 F, abrasion-resistant overcoats for pump impellers, carbon plates that stand up in wet flue gas, synthetic-rubber gaskets for oil lines—these are samples of non-metallic materials that help operators maintain their plants. Many materials, new and almost unknown today, will be the common practice of tomorrow.

Here is a concise review of classified non-metals, old and tried ones as well as new. Necessarily brief is the description of the part each plays in the war on wear. More specific details appear in following pages on atmospheric, flue-gas and water corrosion.

WOOD

IN COMMON with some other non-metals and unlike metals, wood can be sawed and nailed with the simplest of hand tools. Being cheap, compared with possible alternate materials, it is unequalled for temporary construction. Different woods vary in properties from the soft and lightweight balsa to the hard and dense lignum-vitae.

Creosote impregnation and similar treatments give wood resistance to decay and attack by insects. It can be made fire resistant by treatment with complex ammonium-salt mixtures.

Plywood, three or more layers of veneered wood glued together with grain crossed, are used for forms to give concrete a smooth finish. Wood-block floors, with grain vertical, resist heavy traffic. Lignum-vitae makes a water-lubricated bearing for hydraulic turbines; maple and other hard woods, oil-impregnated, serve as bearings.

Exposed tanks and cooling-tower louvres of redwood or cypress have low first cost and no corrosion problem. Wood-stave and square-wood pipe carry paper pulp and other liquids corrosive to iron and steel.

CONCRETE

MOST common as a structural material, concrete and cement mixtures have many other uses, for example, as a protective exterior coating for pipe against soil corrosion and for covering exposed structural steel. Cement-lined pipe resists corrosive fluids and does not plug up with products of corrosion. Sprayed-cement mixture coats walls and flues and is being used for stack lining.

Brick or tile in wet-type cinder catchers is set in acid-resisting cements to combat moist-flue-gas corrosion. For heat and sound insulation, aluminum-bronze powder added to cement acts like yeast to form a light-weight construction concrete. Silicon carbide, or other abrasive, mixed with top layer of floor finish or tile, improves wearing quality and reduces slipping hazard.

RUBBER

NATURAL rubber is valued for its resilience, corrosion and abrasion-resistance. Its properties vary widely with the amount of sulphur and filler it contains—for example, from very soft gum to phonograph-record hardness.

Machinery vibration is absorbed by rubber mountings. Rubber linings are bonded to metals—medium hard for coal chutes, ash pipe and pumps to give abrasion resistance. Somewhat harder rubber, resistant to alkalis and acids, lines pipe, valves, and tanks for handling chlorine solutions and other corrosive liquids. Hard-rubber pipe and fittings are used for strong acids.

Rubber is also a good electrical insulator in cable and tape. Belt dressings usually contain rubber-like gutta percha to give increased friction. A mixture of rubber and graphite makes oil-less bearings. Synthetic rubbers, resistent to oil, grease and gasoline, are serviceable as gaskets in oil lines and for fuel-oil hose. Synthetic rubber stands years of exposure to sunlight.

GLASS

RESISTANT to acids but not alkalies is glass, a material that serves the power-plant operator in many ways. Glass brick lets in light, has good heat-insulating properties, doesn't corrode, and requires no paint. Woven spun-glass fiber finds use as corrosion-resistant filter fabrics and heat-insulating blankets. Safety, or shatterproof glass, is two layers of glass with a cellulose-acetate resinoid between, molded under pressure.

Porcelain enamel (similar to glass) on iron plate protects against moist flue gas and cinder abrasion (not true under water). Chemical stoneware, a fused silica product, is made in special shapes (orifices, nozzles, etc) for corrosive fluids.

ASBESTOS

PRINCIPAL characteristic of asbestos, a naturally occurring fibrous rock, is resistance to fire and high temperature. Main use is for heat insulation, but asbestos fiber, combined with a cement binder, makes a building board resistant to atmospheric and most other forms of corrosion. Bitumastic-impregnated asbestos, non-conducting and non-corrodable, is a material much used for switchboard panels. It also resists wet flue-gas and is abraded only slowly by cinders and flyash.

Bonded with sodium silicate, asbestos fibers form a fire-resistant and heat-insulating paper. Woven into cloth, they make high-temperature and non-corroding filters, and heat-and-fire resistant gloves and clothes. Many

Materials

packings and gaskets for valves and steam lines contain asbestos. Compounded with asphalt or asphalt emulsion, it makes roofing and flooring materials, waterproofing for exposed ducts.

Rockwool (slag fibers) combined with a waterproof binder, as an insulation for refrigerating and low-temperature piping resists moisture absorption. With other suitable binders, it forms sound-absorbent, fire-resistant sheets and blankets for air-conditioning systems.

Asbestos-composition pipe can stand pressure, highly corrosive soil conditions and is not affected by electrolysis from stray electric currents. It also serves for vent pipes for corrosive fumes and for stacks. Molded into rectangular sections, asbestos-composition makes a sound absorbing, fire resistant and heat insulating duct for air conditioning.

PLASTICS

SYNTHETIC resins, when heated and molded with or without filler, are called plastics. The term also includes cellulose (wood-fiber) derivatives, synthetic rubbers, casein (milk-product) and bituminous material. One of the best known general types is derived from carbolic acid and formaldehyde. Except where a transparent product is desired, the resins are combined with a filler, wood flour, asbestos, diatomaceous earth or even woven fabrics. These add strength and hardness to the plastic, and reduce cost.

Plastics are familiar as buttons, unbreakable watch crystals, handles and many other everyday articles. But their resistance to various forms of chemical attack has also developed many applications in the chemical industries, and they are finding increased use in power-plant equipment. With fabric filler, plastics are strong enough for silent gears and special pulleys. Their high electrical insulating qualities and resistance to oil find application in oil-switch parts and supports for transformer coils.

For miscellaneous general service, plastics come in sheets of any thickness from paper to 1-in. board. Various compositions feature strength, heat resistance (to about 400 F), resistance to water and acid or alkaline solutions. They can be made transparent, translucent, or decorative. Marble designs and wood grain can be photographed and reproduced, and substitutes for other building materials made which have properties superior to the original.

CARBON

STRUCTURAL CARBON, as brick, tile, blocks, plates, tubes, pipe and extruded shapes, not only resists corrosive effects of moist flue gas, but its abrasion resistance is sufficient to withstand successfully cutting action of cinder and flyash. It also is not affected by usual flue-gas temperatures. Carbon is one of the few materials that combines these properties to a degree satisfactory for wet cinder catchers and flue-gas scrubbers. Carbon blocks and tile line pulp digesters and tanks.

COATINGS

MOST WIDELY used coating for wood and steel is paint. Coating allows use of cheap, strong materials such as wood and steel for conditions that would otherwise require more expensive kinds.

Paint usually consists of a liquid vehicle and a powdered pigment. Vehicle dries to form a tough film; pigment gives color and opacity to sunlight which would otherwise harm the vehicle. Common vehicles are: raw, boiled and processed linseed oil; tung oil; natural and synthetic resin varnish; bitumastic and asphalt solutions; cellulose lacquers and self-curing rubber compounds. Special oils and solvents suit high-temperature, abrasion- and corrosion-resistant paints.

Pigments are usually oxides, carbonates or other compounds of lead, iron, zinc, tin and titanium. Copper is a pigment in marine paints. Aluminum, in minute flakes, has the property of "leafing," forming layers near the surface of the film, opaque to and 75% reflecting light, and can be used with black bituminous vehicle without changing metallic color of the surface. Lamp black, bone black and artificial graphite are black pigments; bitumastics and asphalts are naturally black.

Paint films protect by preventing moisture from coming in contact with the material beneath. Since paint films are more or less porous, several coats cover pores in each and give longer service. Some pigments are presumed to be chemically active and inhibit corrosion from moisture that may seep through the paint film.

Synthetic-resin varnishes are harder and more corrosion resistant when baked, but air-drying types are suited to most uses. They contain some tung oil; the more oil, the more "elastic" the paint film. Generally more expensive than linseed-oil paints, they are more durable under severe conditions of exposure. Hot bitumastic and asphalt coatings can be applied thickly for abrasive conditions and are nearly impervious to water. They are preferred for tank linings and underwater service. Bitumastics dissolved in naphtha or other solvent can be painted on and have good corrosion resistance.

Metals, melted in a torch-gun, can be sprayed like paint to form a coating. Copper, cadmium, bronze, lead and stainless steel are so used. Cement mixtures, sprayed with compressed air are wear resistant. Rubber and synthetic rubber can be bonded to steel to combat abrasion or corrosion.

OTHERS

LITHARGE, an oxide of lead, and glycerine combine chemically to make plumber's putty, hard and dense when set. Neatsfoot oil, product of animal hoofs, is a preserving oil for leather. Other belt dressings increase friction coefficient and preserve leather.

An excellent rust preventive for unused machinery is petrolatum, a heavy petroleum derivative. Mica finds use in boiler-water glasses, as it is transparent and can stand high temperature, and as sheets for high-temperature insulation and for electrical equipment. Expanded vermiculite, a mica-like material, is a light, fireproof, heat-insulating wallboard and plaster—it will stand red heat. Cork (natural, granular, or sheet) is a vibration-absorbing and insulating material for foundations and piping.

TYPICAL POWER-PLANT MATERIALS AND THEIR USES

	CAST IRON				IRON			STEEL						NON-FERROUS METALS							METALCOATINGS						NON-METALS							COATINGS					
	Gray	Chilled	Low — alloy	High — alloy	Low — carbon	Copper — bearing	Wrought	Low — carbon	High — carbon	Nickel	Stainless	High — manganese	Carbon — moly	Copper	Brass	Bronze	Copper — nickel	Nickel — copper	Lead	Aluminum alloys	Zinc	Cadmium	Lead	Chromium	Aluminum	Cobalt alloys	Wood	Concrete	Tile	Rubber products	Asbestos products	Plastics	Carbon	Oil paints	Resin-varnish	Lacquers	Bitumastics	Cement	Rubber
BUILDING CONSTRUCTION																																						
Structural members	B							B		A						G				A	A	A	A		A		AB	A						A	A	AG	AG	G
Roofing, siding					A	A	A	B						A		A				A	A	A	A		A		AB	A	A		A			A	A	A	A	
Floors, gratings	B		A					B																				B	A	A	A	A			A	A	A		
Architectural trim					B	B	B	B			A			A	A	A	A	A		A		A		A	A			B	A	A			A		A	A	A		A	
Hardware							A			A	A				A	A	A	A		A	A	A		A														
Flues and ducts	BC	CH	CH	CH	AC	AC	AC	BC													A	A				C		AH	AH		AH		H	A	A		H	H	
Stacks, chimneys	B				AC	AC	AC	BC													A							AH	AH		AH		H	A	A		H	H	
Cooling towers	B		A	A	B	B	B	B			F			F	F	F					A	A	A				AF	AF	AF	AF	AF		AF				AF	AF	AF
Tanks, linings	F		F		B	B	B	B			G			F		G	G	G	G		A	A	G				AG	AG	G	G			G	AF	AF		AG	AG	G
STEAM PLANT																																						
Coal-handling parts	E	E	E	E	E	E	E	E	E	E		E				E	E	E								E			E	E			A	A		A	E	E
Ash-sluice liners	D	D	D	D					D	D	D	D				D	D	D								D			D	D		D					D	D
Cinder-catcher parts	C	H	H	H	C	C	C	C	H	C	H	C				H	H	H	H				H			C			H	H		H	H			H	H	
Fan blades, vanes		C	C	C				C		C		C								A						C												C
Piping	GS	GD	GD			FS	FS	FS	ST				ST	F	F				G		A	A	G	A			FG	FG	G	G	G		G	A	A		AG	G	G
Fittings	GS	GD	GD	GD				FS	FS				ST	F	F	G	G	G			A	A	G						G	G				A	A		AG	G	G
Valve bodies	GS		GS					FS	FS				ST		FS	GS	G	G				G																G	G
Valve trim	GS		GS					FS	FS	FS	FS				FS	GS	GS	GS							GS				G									G	G
Pulverizer parts	E	E	E	E					E	E		E																											
Stoker grate bars	E	E	T	T								T																											
Superheater supports	C		T	T					T		T		T																T										
Superheater tubes								T	T		T		T																										
ENGINE ROOM																																						
Turbine blades									S	S	S					S																		D		D			
Condenser tubes					S	S								F	G	G	G																						
Gaskets								S		S	S			FS			S	S	G										G	SG	SG							DG	
Pump casings	G		G					F	F							G								G													DG	
Pump parts	G	D	D					F	F	F	G				G	G	G	G							G														

KEY
A—ATMOSPHERIC EXPOSURE
B—USE WITH PAINT OR COATING
C—CINDER AND FLYASH ABRASION
D—WET ABRASION OR EROSION
E—COAL HANDLING AND CRUSHING
F—FRESH WATER
G—SEA WATER OR CORROSIVE LIQUIDS
H—MOIST FLUE GAS
S—STEAM
T—HIGH TEMPERATURE

Weather Wear

SUN, wind, rain or fog—any one of these alone would be easy to beat. It is their recurring sequence that costs millions of dollars annually in rust, rot and decay. Buildings house important equipment and protect it, although some conditions favorable to corrosion exist inside enclosures as well as out. Other equipment and parts of the building itself are exposed and must be maintained.

Moisture, containing oxygen and carbon dioxide from the air, is the active corroding agent for metals. Rate of corrosion is higher in wet climates, lower in dry. Plenty of oxygen is available all the time, moisture usually only part time. Attack is severe near the seacoast because of minute amounts of salt in the air. Sulphur gas from burning fuel increases corrosion rate in industrial areas. For non-metals, particularly paint, temperature changes and chemical action of sunlight contribute to eventual failure of materials and equipment.

Atmospheric corrosion attacks the *outside* of buildings and outdoor equipment. Therefore, buildings are, in effect, lined on the outside with stone, brick, tile and concrete. When any exposed structure is wood or steel, paint is justified not only for appearance but by longer life of the material beneath. Here are examples of typical atmospheric exposure and what can be done to protect against them:

Structural steel supporting coal towers, tanks or other necessary outdoor equipment is almost never left unprotected. Usual covering is three coats of linseed-oil paint. First consideration is a clean surface to allow paint to "bond" and to ensure that corrosion will not occur beneath the paint film. A stiff wire brushing is the least permissible cleaning. Standard first or priming coat is red lead and raw linseed oil. Red lead, unlike most paint pigments, combines chemically with the oil in drying and hardens into a cement-like compound. Finish coats can also be linseed-oil vehicles with pigments to suit color. Black pigment is graphite or lampblack.

Several other kinds of paint are suitable for steel. Red and blue lead mixture is said by some to be a better primer than red lead. Some finish coats have a "stand-oil" (processed-linseed-oil) vehicle. Synthetic-resin varnishes with aluminum and metallic-oxide pigments are satisfactory for priming as well as finish coats. They vary widely in composition and properties and are pigmented with many different metallic compounds. Some pigments are stated to be inhibitors of corrosion, taking part in the corrosion process to delay or prevent attack.

Asphaltum and bitumastic paints, plain or with aluminum pigment, can be applied to steel directly or as finish in thick coats for very wet places. Hot applied compounds are suited to submerged or partly submerged steel or where ash-and-water mixtures combine abrasion with corrosion.

Steel can be effectively protected by encasing it in concrete. It should first be lightly coated with thin cement-water mixture. Concrete should be dense and free from cracks. In one process, cement mixture is applied by compressed-air spray gun, requiring no forms and obtaining tamping effect by velocity of the particles.

Siding, corrugated or flat, is made of copper-bearing, ingot and wrought iron as well as mild steel. The first three are claimed to have corrosion resistance superior to steel in atmosphere, and therefore, corrosion proceeds less rapidly if the paint film is injured or imperfect. All can be galvanized and it is generally agreed that this type of zinc coating is effective in usual atmospheric conditions. Corrugated sheet iron with a shop-applied external coating of tough, fibrous, nonmetallic material and aluminum painted inside for roofing and siding needs no further protection. Corrugated-copper sheathing also requires no paint but its color can be preserved by clear varnish or lacquer. Asbestos-cement-composition boards, corrugated or flat, have been used for roofing and siding for certain types of construction.

Stacks and chimneys of concrete, brick or tile offer no corrosion problem. Metal construction, riveted or welded, is steel or wrought iron. When lined (see page 72) and not subjected to high temperature, exterior painting follows the same procedure as for structural steel. Special stack paints are available that will stand up to 1000 F. Painting is difficult and expensive and the cost of paint is a small part of total painting cost. Therefore, it pays to use high-quality paints.

Flues, breechings and ducts are exposed to atmospheric conditions on their external sides and air or flue gas within. Conditions do not usually demand special or expensive materials. Boiler flues and breechings are sometimes provided with heat insulation on the outside, sometimes inside and sometimes none at all. From a corrosion standpoint, insulation on the outside must be continuous, tight and well waterproofed to prevent moisture getting at the metal surface underneath when the boiler is out of service. Forethought provides a coating of high-temperature resisting paint underneath the insulation. If the flue has no outside insulation, it should be painted in the same manner as the stack. Exposed cold-air ducts can well be galvanized to minimize corrosion beneath the paint coating.

Architectural trim, for office buildings, store fronts, etc., now employs many materials not heretofore considered for construction. While few power plants are noted for luxury of trim, these same materials suit exposure where painting is impossible or impractical. They include copper, lead, stainless steels, nickel-copper alloys, aluminum alloys and certain bronzes. They also include such coatings as aluminum rolled on steel, chromium, nickel and cadmium electro-plated or metal sprayed. While these metals appear expensive in cost per pound, they can often be used to advantage in thin sheets or as coatings at small total cost. Cadmium-plated bolts and nuts, sheet copper or bronze caps over vent lines are examples. Plastics molded into flat board, tile and asbestos-composition board are non-metallic materials suitable for similar applications.

Danger—O_2 in H_2O

PLAIN water isn't intoxicating, but put in a little alcohol — and see what happens! Likewise, chemically pure water is harmless to steel. If piping systems, tanks, heaters and boilers handled only chemically pure water, there would be no corrosion. But dissolve a little oxygen in it, and harmless condensate or city water becomes plenty of potential trouble.

Furthermore, constantly wetted surfaces (still water) at room temperatures are corroded slowly and unnoticeably. But heat the water, pump it, stir it, or in some other way change its ability to hold oxygen in solution, and you've got the disturbed rattlesnake of corrosion to deal with.

Iron corrodes almost in direct proportion to the amount of dissolved oxygen in actual contact. Alternately wet and dry iron rusts faster than that constantly wet; partly immersed iron rusts most rapidly at the water surface—in each case the increased oxygen where or when water and metal meet boosts the rate of attack.

Piping for fresh water and condensate is usually "black iron" (actually low-carbon steel) or wrought iron—screwed, welded or with companion flanges. These are least expensive materials and constructions. For mild corrosion, galvanizing may be resorted to. Cast-iron pipe with integral flanges is not much more expensive in sizes 4 in. and over, and offers thicker walls to resist corrosive attack. For handling cold water or non-corrosive fluid (air, oil), cheapest materials have long life, and no extra expense is justifiable.

FEEDWATER is heated to 400 F in some modern high-pressure plants before it reaches economizer or boiler. Economizer may add 50 to 100 F more. At these temperatures, dissolved oxygen attacks steel rapidly. Changing pump, piping and heater materials only aggravates corrosion of economizer and boiler. The preferred goal is to keep all possible oxygen out by holding condenser air leakage at a minimum, sealing pump glands and using deaerating feedwater heaters.

Nearly all oxygen that remains in the system eventually combines with iron. To eliminate last traces, dissolved oxygen is sometimes neutralized with sodium sulphite. This chemical must be introduced continuously into the feedwater system in proportion to oxygen present. The theory is that oxygen prefers to combine with the sulphite instead of iron piping and that, in the process, the sulphite is changed to sodium sulphate, normally added to boiler-drum water as feedwater treatment.

Large boiler-feed piping at high pressure should be high-quality seamless steel tubing; welded construction is preferred to flanged. Large condensate piping for low pressure can be integral-flanged cast-iron. Smaller sizes require only lowest-cost materials suitable to pressure.

Steam is not corrosive to iron except at very high temperature. In superheater tubes, for example, it can combine with steel directly (without moisture) to form black iron-oxide scale, harder than rust, chemically different but equally damaging. Steam does not affect piping materials, however, at highest steam temperatures now in use.

For steam piping operating at temperatures over 800 F, carbon-molybdenum steel, (moly about 0.5%) has been accepted as standard within the past few years. Use of alloy steel results from need for material to resist creep, gradual plastic flow at high temperature.

Cast iron is permitted for pressure up to 250 lb, but should not be used at temperatures over about 450 F, above which it "grows" gradually and loses strength.

BOILER DRUMS are rolled or forged steel, not usually classed as alloy, even though small amounts of other metals are added in the ladle to insure best qualities. Corrosion can come from uneven distribution of feedwater and insufficient or improper feedwater treatment. Intercrystalline attack by concentration of alkaline chemicals near rivetheads and seams is "embrittlement," prevented by maintaining proper chemicals in drum water. Protecting interior surface of drum with special paint is usual practice.

Superheater tubes for high temperatures are medium-carbon alloy steels containing molybdenum, nickel, chromium and titanium. In many cases most of the superheater is carbon steel with a high-temperature section of alloy steel.

Valve bodies can be purchased in practically every material that can be cast and machined, with ends prepared for flange, screw or weld connections. Bodies can be cadmium-plated where corrosion is a problem. Cast carbon-moly steel is standard for 900-F temperature. For corrosive or abrasive conditions, rubber-lined valves are ingeniously designed so fluid handled does not come in contact with the metal.

Valve trim, seat rings and disks are subject to galling, wire drawing and other conditions not experienced by other parts of the same piping system Hard and erosion-resistant materials are furnished for standard valves They include stainless steel, nitralloy and hard-facing alloys. Stems and bushings for governor and control valves should be of different materials to prevent galling. One technical investigation shows that grooving the stem reduces galling effect.

Turbine blades are phosphor bronze, nickel steel or stainless steel. Stainless steel retains a smooth surface longer and is standard for high-temperature, high-pressure turbines. Shields of hard-facing alloy can be applied to blading for lower stages where moisture erosion is serious.

PUMP CASINGS for centrifugal pumps are cast in iron, steel or bronze. For condensate or feedwater service, "close grained" cast iron or "semi-steel" (both are refined cast iron with high tensile strength) are standard for low and moderate pressures. High-pressure boiler-feed-pump casings are cast steel or of forged-and-welded construction. Casings may be had in bronze and many other castable alloys for special service such as boiler-feed-treating solutions.

Pump impellers, wearing rings and sleeves are bronze in standard pumps for condensate service. Where galvanic action is likely, "all-iron" or "all-bronze" trim is furnished, impeller, casing and trim all the same type of material. Stainless-steel impellers, wearing rings and shaft sleeves give longer life in "all-iron" pumps without introducing galvanic action. Nickel and copper-nickel alloys trim bronze pumps for corrosion resistance.

Pump shafts require high-strength materials, heat-treated high-carbon stainless or high-tensile steel. For

bronze-fitted pumps, high-strength bronze or nickel alloys avoid galvanic action.

Pumps in condensate systems sometimes show erosion at the impeller eye due to cavitation. This results from too low a suction pressure so that oxygen is literally pulled out of solution. Best cure, if practical, is to increase suction pressure.

Feedwater heater tubes of arsenical copper are being used in some of the high-pressure stations in preference to the traditional Admiralty because of better resistance to feedwater alkalinity occasioned by feed treatment.

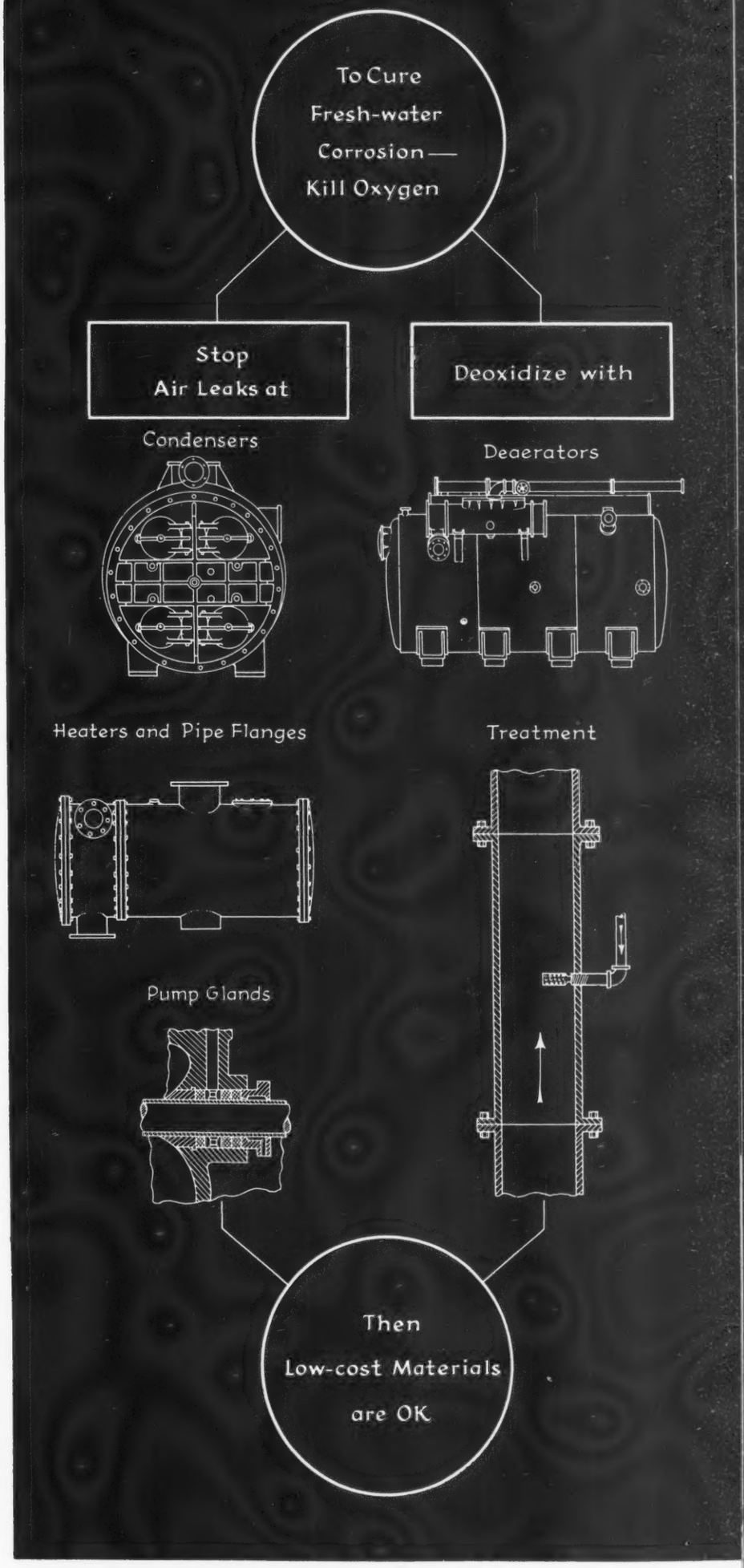
Cooling systems for internal-combustion engines can be black iron or wrought-iron pipe if a system is closed. For cooling tower or well water, cost of red brass is sometimes justified.

Cooling-tower piping and louvres are subject to an artificially created form of severe atmospheric corrosion. Louvres of cypress or redwood suit this particular wetting action, and should be remembered for similar conditions encountered in other equipment. Galvanized-iron louvres and frames are used in small towers. Cadmium plating is effective for small parts, nuts, bolts and the like.

HOT WATER and cold water can be circulated for years in closed heating or cooling systems without more than a trace of corrosion. Closed systems operating under slight pressure afford no opportunity for absorption of oxygen. Chilled-water circuits for air-conditioning systems, in which air washers pick up oxygen, operate at low temperatures where corrosion rate is low. In some cases, engineers have chosen to specify red-brass piping, the choice being based on economic evaluation of higher first cost against possible corrosion effects.

Hot-water supply systems present problems due to varied characteristics of water supply and continued replacement of dissolved oxygen. Galvanizing is not recommended for temperatures above 160 F. Failure comes from corrosion at threads or plugging up of pipe with products of corrosion and scale. Copper tubing, plain or tinned, common or red-brass pipe are alternate materials that have been successful with some water supplies. Iron pipe is also available with brass, copper, tin, lead and cement linings.

Heating-system condensate returns from steam radiators corrode more rapidly when the heating cycle is such as to draw air into radiators frequently. Vacuum systems reduce air quantity entering. Choice of materials for replacement is same as for hot-water heating systems, but includes wrought-iron and copper-bearing iron.



Getting Along With

CIRCULATING-WATER and cooling-water supplies have to be taken as they are found. Sea water and harbor water contain salt and all kinds of impurities, both chemical and organic. River water can be harmless or corrosive in proportion to the characteristic of the soils in the watershed or the industrial wastes collected. Well-water and city-water supplies are generally of better quality, but even these often contain scale-forming solids as well as dissolved gas.

Ordinary salt and water do not corrode metals directly. That is, there is nothing acid or oxidizing about salt that attacks even ordinary iron. But salt water is a good conductor of electricity, many times more so than drinking water, for example. Because of the electrical nature of corrosion, it proceeds at a much faster rate in a conducting fluid. Even small amounts of materials that can start chemical action will cause a condition that can continue, the products of corrosion forming one part of an electric cell, the metal itself the other.

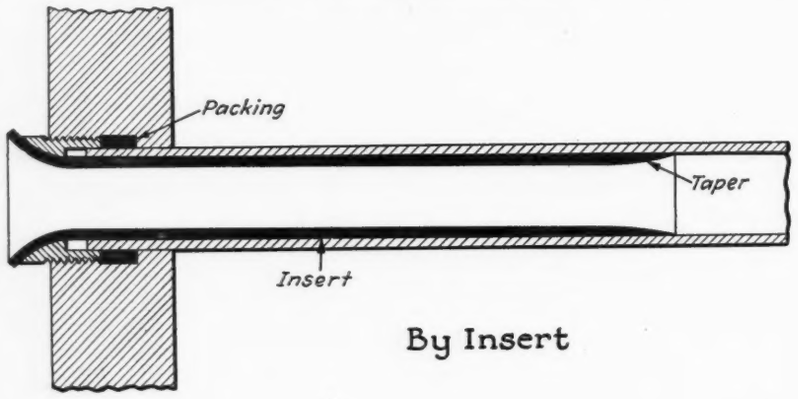
Thus slight acidity or oxygen content can be serious in salt water and quickly destroy piping or pumps. The same is true of fresh-water supplies if they contain enough dissolved solids to increase electrical conductivity. Also, decomposition of animal and vegetable matter produces acids which, though weak in themselves, may accelerate corrosion. Harbor waters are generally more corrosive than relatively clean sea water for this reason.

CIRCULATING water for condensers is usually handled in large quantities compared to other water supplies. This favors use of concrete tunnels instead of pipe, or results naturally in the selection of cast-iron pipe of comparatively thick section. Concrete has excellent resistance against sea-water attack, and many instances exist of cast-iron pipe in service for condenser supply for 30 years or more.

Any high-velocity condition or sharp turn in sea-water stream flow produces conditions favorable to corrosion, erosion, or a combination of the two. By increasing turbulence, electrochemical differences are set up which start galvanic action. Action proceeds faster in warm water than in cold. Any small disturbance to flow, such as a projecting flange or an imperfection in the metal surface, may be a starting point for corrosion.

Power-plant use of large quantities of sea water or unpurified water is usually confined to cooling effect in steam condensers and heat exchangers, but may also include sluicing of ash.

CONDENSER-TUBE INLETS ARE PROTECTED



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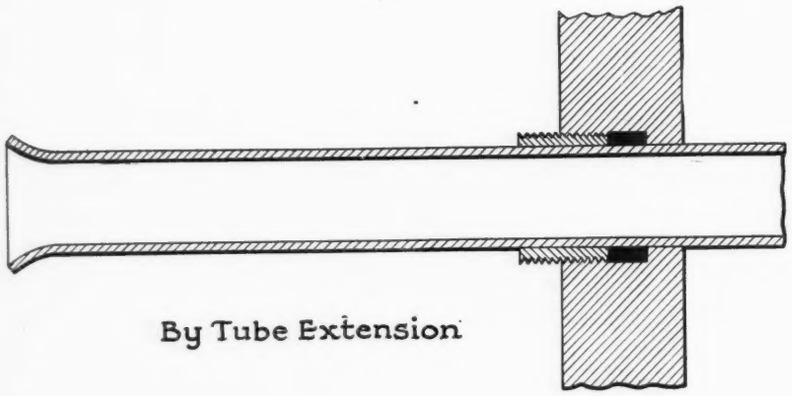
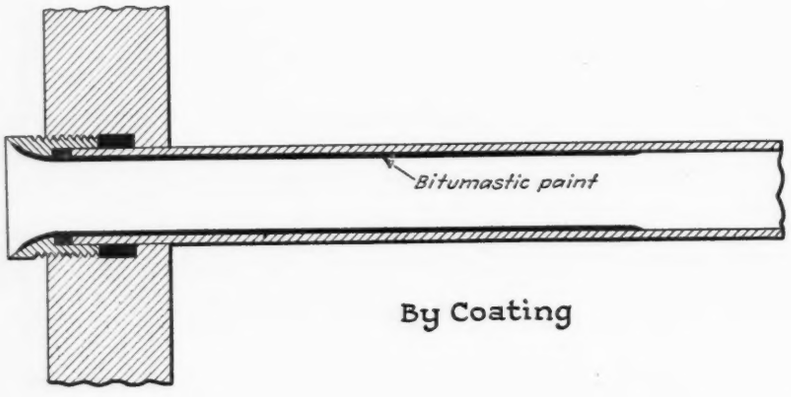


By Tube Extension



By Coating

Old Man Neptune

and cinders. In a few cases, water washes flue gas for cinder and flyash removal.

Piping for circulating water is usually of large size and operates at low pressure. Cast iron has been proved satisfactory in resisting corrosion over a long period of years provided low water velocities are maintained. When water flows through pipe at high vacuum (as in condenser tail pipes, oil coolers and heat exchangers high above tail water), oxygen released by the vacuum sometimes produces a severe corrosive action on pipe walls, valves, thermometer wells, etc. Possible remedies are cement and rubber linings, or restriction of flow to reduce vacuum. Thermometer wells of nickel-copper alloy have given good service in salt water at high vacuum. Small lines are preferably all brass, with bronze fittings and valves. These include stoker sprinkler lines, quenching-water supply for slag-tap furnaces and ash-sluice supply piping.

Valves for large pipelines are cast iron with machined seats, bronze or nickel-copper trim. For smaller lines, bronze valves can be used with cast-iron pipe. If serious galvanic corrosion results, most likely cure is brass piping. Special bronze compositions are available for acid mine waters, others for alkaline waters. Valves are also made in all-copper-nickel alloy for unusually severe service.

PUMPS of relatively large size and low head have cast-iron casings. Impellers are bronze, as are shaft sleeves and wearing rings. The Navy prefers nickel-copper alloy. Shafts are high-strength bronze or nickel-copper alloy, although corrosion-resistant steel has been used with success.

Condenser water boxes are made of cast-iron even when the remainder of the shell is welded-steel plate. Water-box designs have been developed that minimize turbulence in an effort to prolong condenser-tube life. Water-box interior surfaces can be painted with bitumastic paints if corrosion is severe, but painting is not found necessary in the majority of installations.

A patented device for breaking up flow in condenser-inlet water boxes is claimed to reduce erosion of tube inlets. Another maintains an imposed electric current from anodes in the water box to the condenser tubes intended to prevent tube corrosion.

CONDENSER TUBES represent one of the few cases where a complete protective coating is impractical because of reduced heat conduction. Neither can the quality of water be changed in practice to reduce its corrosive activity. Water velocity through the tubes must be reasonably high, 5 to 9 fps, to obtain high heat-transfer rates. Materials must be capable of being drawn into a perfect tube and stand long-time exposure to sea water.

No one condenser-tube alloy will give best service under all operating conditions, taking cost into consideration. In some instances, nothing but the highest-priced material will give satisfactory results, in others less-expensive alloys give long service.

Deoxidized copper and arsenical copper are recommended for good river water where pollution and silt are not present. They have practically replaced the older Muntz metal. For polluted salt water, aluminum brass has been found superior to the traditional Admiralty in several installations. It is also resistant to impingement attack, forming a thin self-healing protective scale. Copper-nickel alloys and aluminum bronze suit severest conditions for which added expense can be justified. Special 88-4-4-4 bronze is suggested for acid mine waters; red brass where earlier failures were due to dezincification. Selection among available alloys depends on experience of neighbors having similar water conditions.

Condenser-tube inlets are subject to a combined corrosive and erosive effect from release of dissolved oxygen bubbles. Protection methods include metallic inserts extending several inches into the tube, by extending the tube ends several inches beyond the tube sheet and cutting off the extension when worn through, and by painting inlets with bitumastic or synthetic resin paints good for underwater service. Other possibilities are turning tubes end-for-end, cutting off several inches and brazing on new ends and stretching tubes to allow cutting off ends.

Ash-sluice troughs and piping get the most severe combination of abrasion and corrosion of any part of the plant. A mixture of salt water and ash contains traces of many impurities from both sources. Chilled cast iron is the best wear-resistant material if not adversely affected by the accompanying corrosion. It cannot be machined; design must allow simple assembly. Nickel cast-iron and high-silicon cast irons resist the corrosive action better. The former is machinable, not as hard as chilled iron. The latter is attacked by weak sulphur compounds which may be present in the ash. Rubber linings, about as hard as automobile-tire material, are completely resistant to the corrosive effects but must present a smooth inner surface at joints.

Refrigerating brine of calcium chloride, if pure, is not seriously corrosive. Its potential corrosiveness is brought out by the presence of oxygen, ammonia or other impurities that can start attack and enter the reaction. Traditional piping material is wrought iron, but many installations operate with black-iron pipe. Regular checking of brine purity, maintaining a slight alkalinity, and keeping air out of the brine circuit do the trick.

CONDENSER-TUBE ALLOYS

MATERIAL	COMPOSITION PER CENT
Copper	Copper, 99.9+
Deoxidized Copper	Copper, 99.9+
Arsenical Cooper	Copper, 99+; Arsenic, 0.3
Muntz	Copper, 60; Zinc, 40
"2 and 1" Alloy	Copper, 67; Zinc, 33
Arsenical Brass	Copper, 67; Zinc, 33; Arsenic, 0.05
Admiralty	Copper, 70; Zinc, 29; Tin, 1
Antimonial Admiralty	Copper, 70; Zinc, 29; Antimony, 0.1
Special Bronze	Copper, 88; Zinc, 4; Tin, 4; Lead, 4
Red Brass	Copper, 85; Zinc, 15
Aluminum Brass	Copper, 76; Zinc, 22; Aluminum, 2
Aluminum Bronze	Copper, 95; Aluminum, 5
Copper-Nickel "70-30"	Copper, 70; Nickel, 30
Copper-Nickel "80-20"	Copper, 80; Nickel, 20
Special Alloys	Copper, 75; Nickel, 20; Zinc, 5
	Copper, 70; Nickel, 29; Tin, 1
	Copper, 82; Zinc, 15; Aluminum, 2; Tin, 1
	Copper, 80; Zinc, 17; Aluminum, 2; Nickel, 1

Auxiliary

IN THE war on wear, it is not always necessary or economical to produce hardness or corrosion-resistant qualities throughout the entire thickness of metal. By treating steel surfaces with chemicals and heat, desired properties may be developed to a high degree in thin surface shells. In some of the processes, chemical penetrates the surface to form an alloy. In others, metal or alloy is deposited on the surface to form a permanent and integral part of the metal.

By surface treatment, low-cost iron and steel can be adapted to many applications ranging from everyday service conditions to special uses in severe environment. Some effects are made available that could be produced in no other way. In other cases, cost is less than other possible materials or construction, and in other cases, surface treatment permits repair instead of replacement. A few important ways of producing surface hardness or corrosion and erosion resistance are listed here.

Carburizing, (case-hardening) produces a hard outer surface on steel and leaves inside core material tough. Suitable carbon steel (0.15% carbon) is heated to 1600 F or more while packed in carbon-bearing material and chemicals, then quenched. The carbon penetrates the steel to a slight depth, increasing hardness of the outer surface. Typical application of carburizing is for hardening wearing pins and gear teeth.

Nitriding produces a harder surface than carburizing and does not require as high temperature or quenching. Complicated shapes can be hardened without distortion. Steel for nitriding is an alloy containing about 1.25% aluminum and small amounts of chromium and molybdenum. The process requires heating for 12 hours at about 1000 F in ammonia gas, then raising temperature to 1200 F for another 12 hours. Nitrogen from the ammonia combines with the steel to form a hard but extremely thin shell.

Parkerizing is a method of coating steel or iron surfaces with a thin phosphate covering resistant to mild atmospheric conditions. A similar process, **Bonderizing,** is intended as a base for paints, being applied to prevent rust from spreading beneath the paint film if the latter is injured, as might happen on metal window sash and framing.

Galvanizing consists of coating iron or steel with zinc by dipping in molten metal or electroplating. Zinc, which actually corrodes more readily than iron, develops a protective scale in atmosphere. If this scale is not dissolved or scraped away, the coating lasts indefinitely. If underwater in even mildly acid conditions, the scale is attacked, exposing the zinc itself, and metal life is not appreciably increased. The zinc, however, by corroding in preference to the iron or steel, tends to wear away evenly, completely protecting the iron, which forms no pits until the zinc has almost disappeared.

Sherardizing is a process similar to galvanizing in that a zinc coating is applied to steel. Metal to be coated is heated to 700 F in drums filled with zinc dust. The surface is rougher and more porous than galvanizing and will hold paint without preliminary brushing or weathering, necessary in the case of galvanizing.

Hard facing offers a means of applying corrosion or abrasion-resistant metals at the point of maximum wear by electric arc or gas welding. Although stainless steel, nickel-copper alloys and cobalt-chromium-tungsten alloys are usually used, welding rods of many other compositions are available. In general, steel and cobalt alloys are applied to cast iron or steel, nickel and copper alloys to non-ferrous metals. Depositing hard-facing alloys requires care and expert technique to obtain a good bond and avoid cracks in the surface applied. Thickness of hard facing need be only ⅛ to ¼ in.

For abrasion resistance, chromium, tungsten, manganese and silicon steels, cobalt-chromium-tungsten alloys and tungsten-carbide alloys provide a wide range of hardness. Some are all-purpose low-cost materials, others offer special qualities such as hardness maintained even at red heat.

Most hard-facing materials are highly resistant to corrosion and erosion as well as abrasion. This quality depends somewhat on the corroding

ANTI-CORROSION TACTICS

1. Wear does not happen suddenly. Only when inspection methods are inadequate or neglected entirely is emergency repair needed.

2. If fast action does become necessary, consider only standard materials that are known to give reasonably good service.

3. Don't expect a complete and perfect solution to corrosion problems. A fair balance between cost and service life works out better.

4. Find the cause of corrosion. Even a doctor has to diagnose a case before he prescribes treatment.

5. List five possible remedies. Then choose the best available instead of pinning your faith on a chance suggestion.

6. Read, ask questions and keep a file of information on materials. Someone has probably met your problem before, and may have solved it.

7. Don't overlook the possibility of removing the cause of corrosion. A little expense incurred before trouble starts can save expensive replacements.

8. Don't be afraid to experiment on a small scale under actual operating conditions. Practical results may avoid large-scale expense.

9. If one pound of material is all that's needed, cost is not important. If thousands of pounds are involved, investigation should be extensive.

10. Put your problem on paper, write all you know about cause and cures, then collect suggestions. Ideas spring up around a collection of facts.

Weapons

agent, and selection of material should be made to suit a known condition. Hard facing may be applied to cast iron, alloy cast iron, brass, bronze, copper and other non-ferrous alloys as well as most steels.

Turbine-blade shields to prevent moisture erosion in lower stages, valve seats and disks for high-temperature steam and for internal-combusion engines, nozzles for high-head hydraulic turbines, are all typical users of hard facing. Field application to pump casings and impellers, fan housings and coal-handling equipment illustrate application for repair to avoid replacement. Experience justifies the conclusion that parts repaired with hard-facing outlast new ones of the original material.

METAL SPRAY is another process for applying molten particles of all but extremely high-melting-point metals to any material, metal or non-metal. To prevent corrosive attack, a soft metal such as lead or zinc is first sprayed on by an oxy-acetylene torch-gun, followed by a coat of hard metal such as stainless steel.

Sprayed coatings are not impervious to moisture, being composed of interlocking spattered particles. Soft metal, sprayed and then brushed or ground, will form a satisfactory seal for all practical purposes; hard metals give protection to the soft one beneath.

Against certain forms of abrasion, pervious metal coatings have certain advantages. For example, a worn bearing journal, sprayed with the same material as the original, will show longer wear because lubricant permeates the coating and gives some of the characteristics of an oilless bearing.

Sprayed coatings which are hammered or heated to an extent that expansion differentials become important, may lift off. Pressure applied to the jointing line of sprayed coating and base metal may cause similar lifting. This is avoided by welding on a bead to create a collar against which the metal is then sprayed. For spraying, essentials are a clean, rough surface, obtained by rough machining or sand-blasting. The rough surface provides pockets and ledges behind which sprayed particles can lock.

Rolled coatings of aluminum, nickel, and tin are applied to steel sheets. Steel also comes lead covered, called terne. **Electroplating** is the application of metal coatings by electric current. Copper, nickel, cadmium chromium and silver are usual plating materials. Principal power-plant application is for meter parts, nuts, bolts, and hardware.

DESIRABLE QUALITIES of a material from the user's standpoint are strength, hardness, toughness and corrosion resistance. Add to these the necessary qualities important to the manufacturer: casting qualities, machineability, suitability for rolling, drawing or forging. Different alloys possess these qualities in varying degrees, determining how well they suit each possible application.

Hardness is the resistance of a substance to penetration by another material. It is a measure of resistance to abrasion and cutting. Determined by a Brinell machine (which forces a hardened steel ball against the material with known pressure), hardness number corresponds to the diameter of the indentation. The Rockwell method uses a 1/16-in. diameter spherical point (Rockwell B) and for harder materials a conical diamond point (Rockwell C). Relation between these hardness scales, Scleroscope scale and ultimate strength can be found from Data Sheet 73, page 80.

Corrosion resistance is the ability to stand up under chemical attack. Some metals are inert to (not attacked by) corrosive conditions, others from a protective scale. Laboratory tests give indications only; actual trial in place is the only real measure of corrosion resistance.

Creep strength is the load a metal can take at high temperature without a gradual permanent stretch of more than 1% in 10,000 or 100,000 hours.

These are only a few of the properties of metals most useful in the war on wear. Other properties sometimes sought are: toughness, resistance to shock, electrical conductivity or resistance, magnetic or non-magnetic qualities, low or high melting point, high or low coefficient of expansion, ductility and lastly, appearance.

Bibliography

MUCH has been written about corrosion, erosion and abrasion. Handbooks contain summary information applying to a wide field, but the great majority of up-to-date data is in technical papers and publications. Because the subject is so broad, the field of any single book or article is limited to some particular phase of application. That is why **Power** produced this very simple summary of wear in the power field.

For more complete and specific information on the theory and mechanism of corrosion, books are listed here. For materials, technical literature (too extensive to list) and the manufacturers should be consulted. Here are a few book sources.

Handbook of Engineering Fundamentals — Esbach (John Wiley & Sons). Metallic Materials, 110 pages; Non-Metallic Materials, 84 pages. **Mechanical Engineers' Handbook (Design and Shop Practice)** — Kent (John Wiley & Sons). Iron and Steel, 60 pages; Corrosion and Corrosion-Resistant Metals, 26 pages; Non-Ferrous Metals and Alloys, 68 pages; Non-Metallic Materials, 38 pages; Fabricated Materials, 52 pages.

Engineering Alloys — Woldman and Dornblatt (American Society for Metals). Lists 8200 alloys, classified by name, composition, properties, and uses with reference to manufacturers. **Materials Handbook** — Brady (McGraw-Hill). Lists commercial and industrial materials by trade name with reference to source or manufacturer.

Corrosion Resistance of Metals and Alloys — McKay & Worthington (Reinhold). Covers theory and forms of corrosion, metals and alloys and their corrosion-resistant properties under specific exposure. **Corrosion — Causes and Prevention** — F N Speller (McGraw-Hill). Especially applicable to power-plant and heating problems. Emphasis is on what causes corrosive action and on specific ways already in use for prevention.

Welding Handbook — (American Welding Society). Procedure and materials for hard-facing, repair by welding and metal spray.

Gas Attack

FLUE GAS from the combustion of fuel leaves boiler or final heat-absorbing surfaces in a hot, dry condition. The gas may contain cinders, in the case of stoker-fired boilers, flyash from combustion of pulverized coal, or light flaky soot from oil burners. None of these solids presents a corrosion problem, although abrasion of induced-draft fan blades and casings may result where solid content is high.

Traces of several potentially corrosive chemicals are present in flue gas. Principal among these are sulphur compounds, which when wet, attack metal rapidly, particularly in dilute solution. Most acids increase severity of attack with greater strength from very dilute to 10 or 20% concentration. Acids formed from sulphur, however, attack metals even when very weak.

Flue gas can get wet by being cooled below its dew point or from water added in wet-type cinder catchers. The former can occur in air preheaters near the cold-air inlet, or when one boiler of a number connected to the same flue is out of service. Dew point is also reached if flue gas travels through too long an exposed, uninsulated breeching, or in rare cases, in an unlined stack.

Although the calculated dew point of flue gas averages about 150 F, corrosion affects may be found if gas temperature falls below 250 or 300 F. Temperature near the metal surface of breeching and stack is lower than in the main stream, and condensation can occur with the main stream of gas at apparently safe average temperature.

Stack Lining

Iron or steel stacks would require no lining if temperatures could be depended on to stay above that at which condensation occurs. Many engineers prefer to line medium or large stacks rather than to risk having future operating conditions that might result in corrosion. Usual procedure is to line with brick, leaving about ½-in. space between lining and metal. Sprayed-cement coating, new alternate material, is applied directly to the stack metal. Present practice is to put on only about 2½-in. Linings have a heat-insulating effect which slightly increases available draft and minimizes loss of temperature and possibility of condensation.

Fan wheels, vanes and casings subject to cinder or flyash abrasion without accompanying moisture corrosion can be protected by hard-facing alloys. Usual practice is to deposit weld beads perpendicular to line of gas flow. Beads 2 or 3 in. apart will protect flat surfaces; for curved surfaces, beads are brought closer together.

Wet cinder catchers, found in a few plants, have afforded a proving ground for materials exposed to combined effect of moist flue-gas corrosion and cinder abrasion. Combined action is severe, affecting stainless steels and other alloys resistant to common kinds of corrosion. Lead, bonded to steel, resists corrosive effect but is gradually worn away by cinder abrasion and "grows" at prevailing temperatures.

Non-metallic materials have been found more satisfactory for most uses in flue-gas scrubbers. Concrete, tile and chemical stoneware resist both acid attack and abrasive effects where structural limitations permit their use. Porcelain enamel on steel stands high temperature and abrasion; it should not be exposed under water or where it is continually wetted. Structural carbon, now made by an extrusion process, is practically non-corrodable. Synthetic-resin and asbestos-bitumastic composition boards have been successful but are limited to about 400-F temperature.

LIST OF SPECIAL SECTIONS
Published in *Power*, to date

SUBJECT	NO. OF PAGES	DATE
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DIESEL DATA	19	JUNE, 1935
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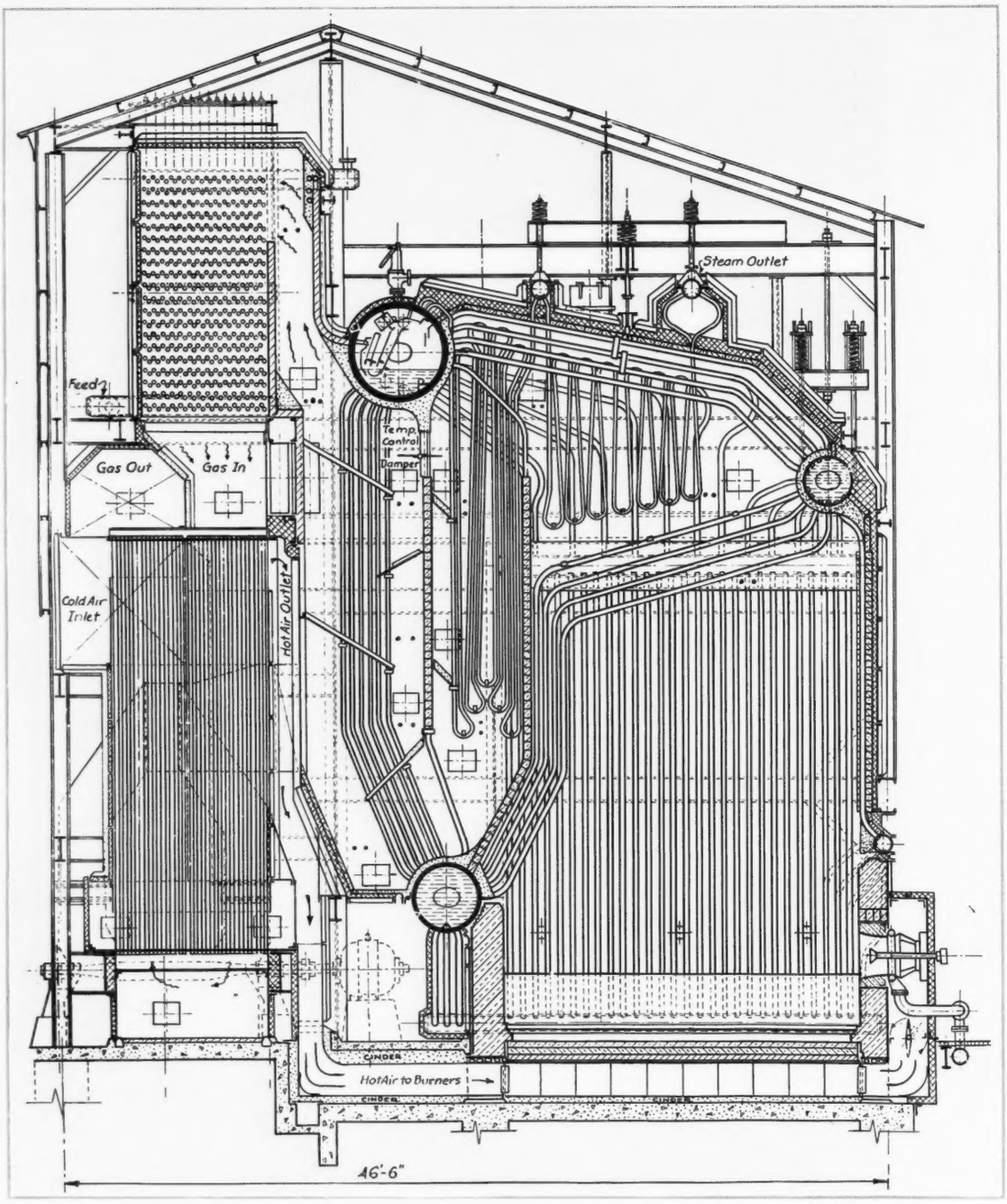
WAR ON WEAR	16	SEPTEMBER, 1938

Wide World Photo

Boulder the Magnificent

Boulder Dam on the Colorado River (a U S Bureau of Reclamation project), seen from the door of an airliner, presents a truly magnificent spectacle of beauty and power. The dam, 735 ft high, will eventually impound 30,500,000 acre-ft of water, the largest artificial reservoir in the world. Present storage in Lake Mead is over 22,000,000 acre-ft (about 500 ft deep). Four towers above the dam contain control gates for penstocks leading to two powerhouses below, designed for 1,835,000 hp total capacity. One 55,000-hp and six 115,000-hp Francis turbines are now in operation or ready for operation, and two more are being installed.

TWO RECENT RILEY CENTRAL



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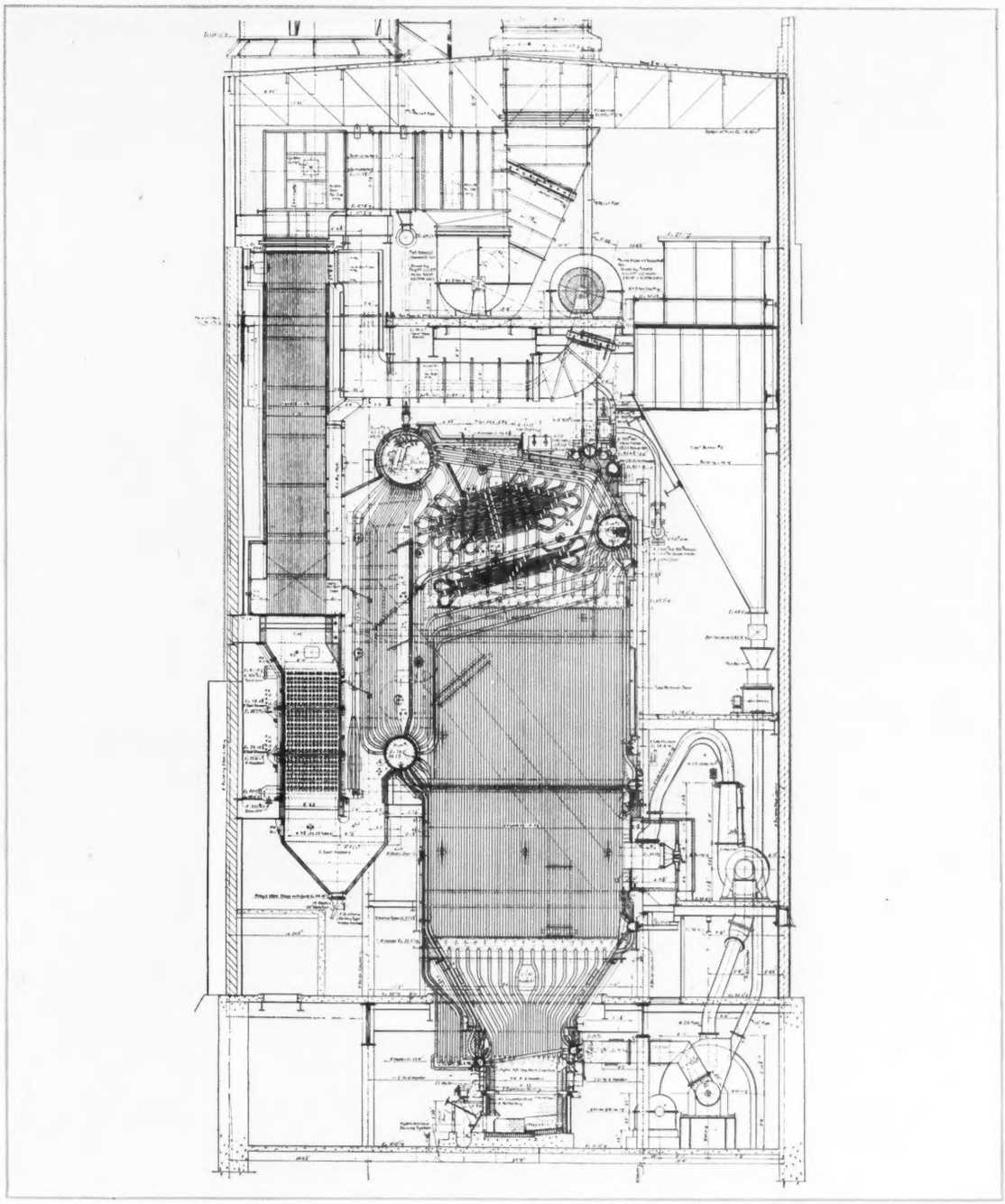

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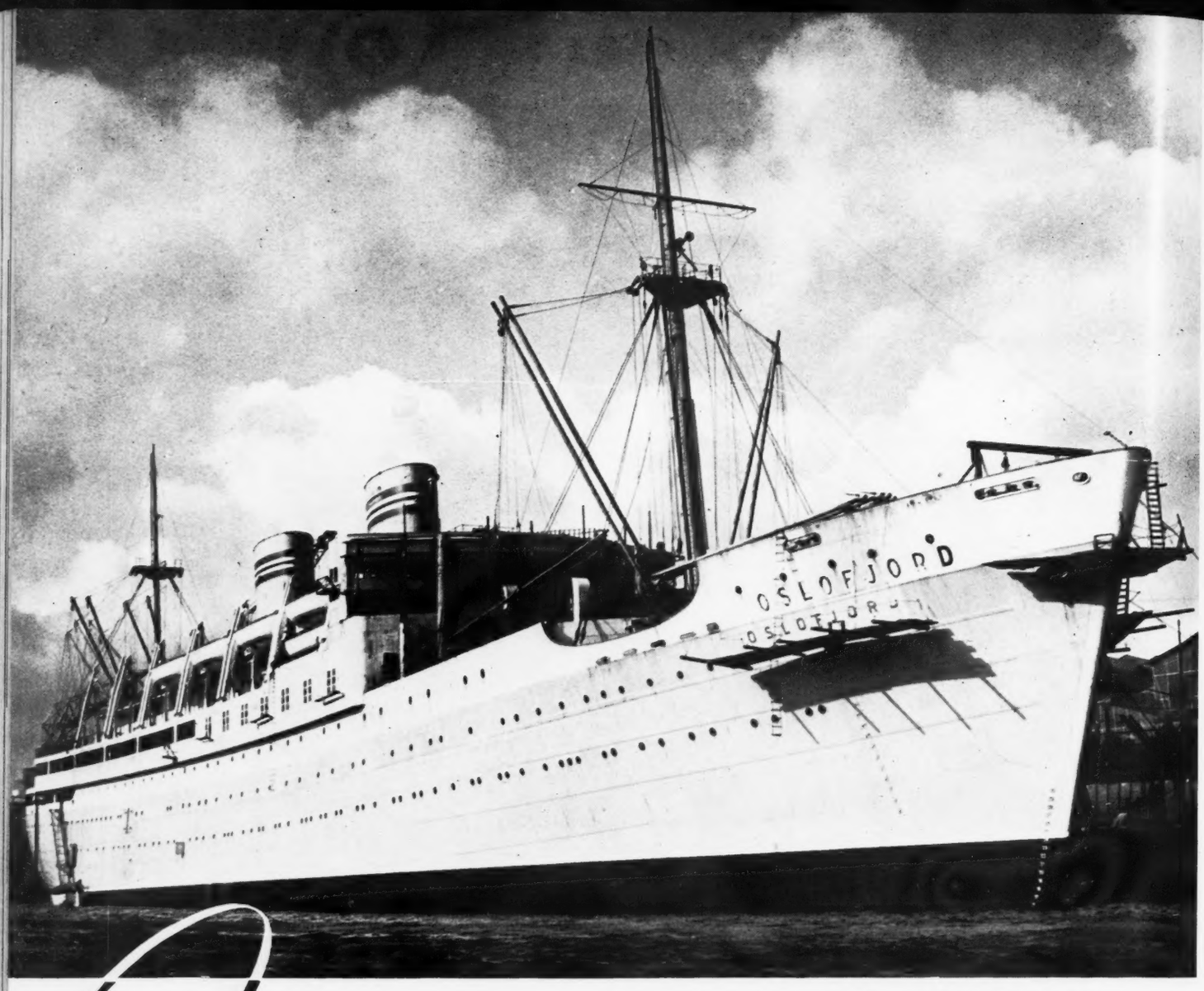
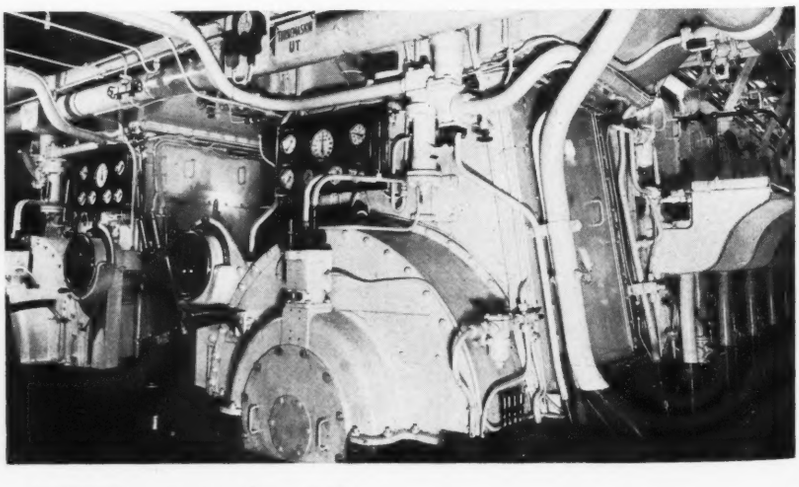


Fig. 1—As modern on deck as below, Oslofjord has all-electric steering gear, gyro compass with repeaters, electrical submarine log equipment, and echo sounding machine. Hydraulic-coupling drive permits any combination of four engines for maneuvering or emergency

Norse Power

Fig. 2—Looking aft at two of the four 5400-hp, MAN, solid-injection diesels. These serve the starboard propeller, each driving a pinion gear through a hydraulic coupling

Norsemen, sailing the North Atlantic since Leif Erikson made the first crossing in the year 999, carry on the tradition with the Oslofjord, new flagship of the Norwegian America Line. Of 18,675 gross tons, she is the largest and highest-powered vessel with geared diesel propulsion; makes 19½ knots with 21,600 hp.



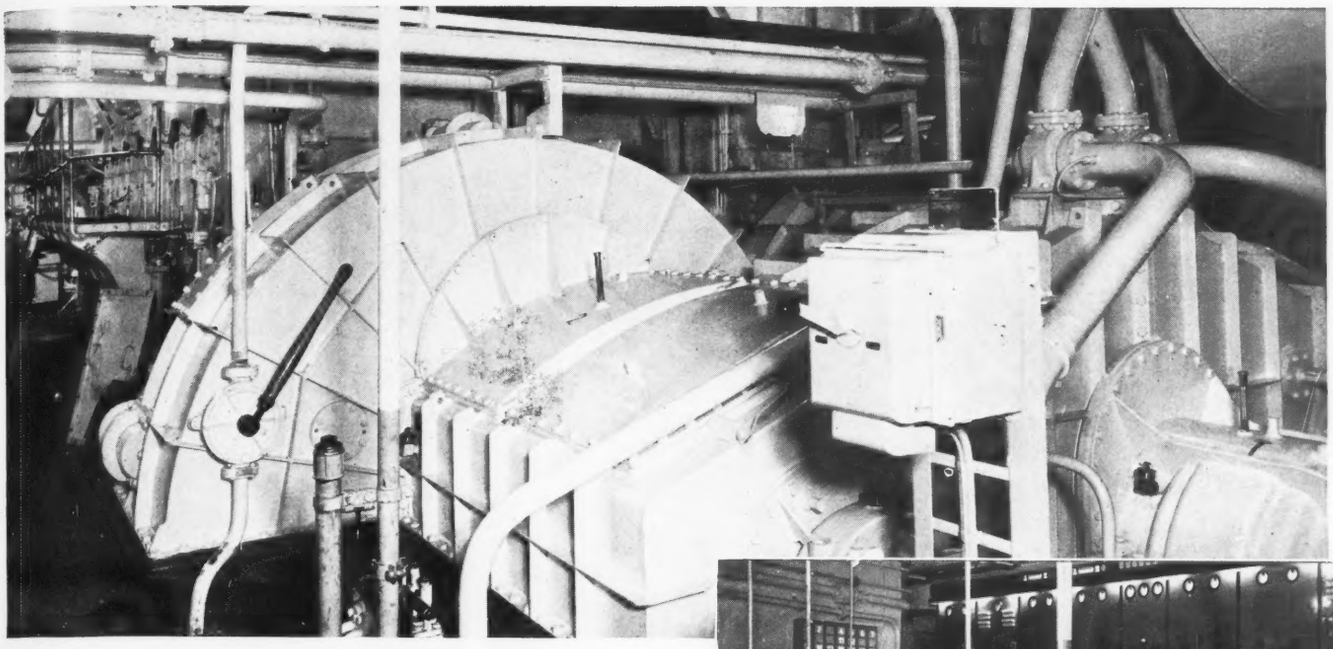


Fig. 3—Looking forward past the gear housing at the hydraulic couplings which allow very low propeller speeds with normal engine speed. Either engine can be disconnected by controlling oil in the coupling

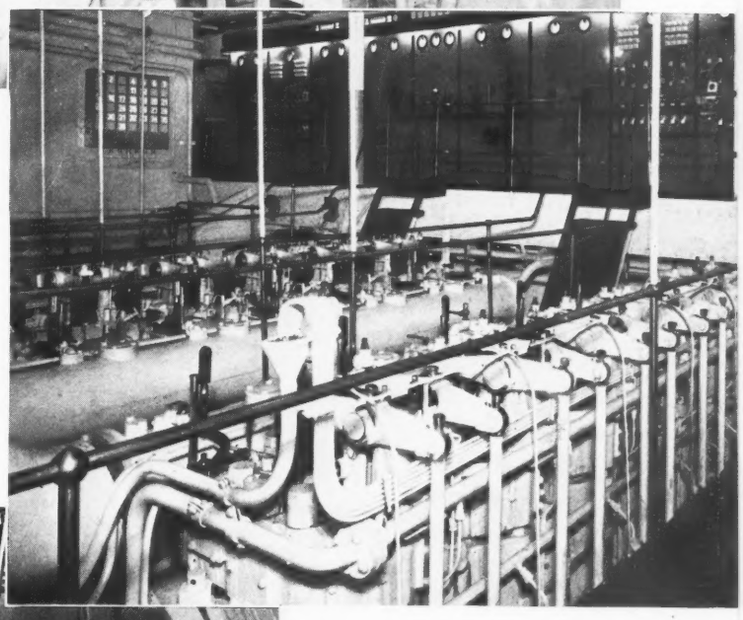
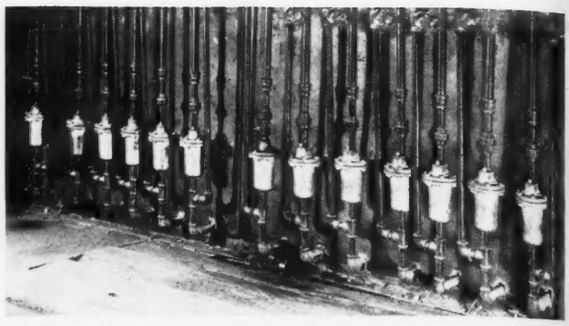


Fig. 4—Auxiliary-power supply panel and control board equals best shore practice. Valve gear showing is that of two auxiliary-power diesel sets

Fig. 5 — Well - lighted, ventilated and spacious companionway; looking upward at the power-supply board

HOW TO INCREASE

LAUNDRY In Honolulu, the American Sanitary Laundry found itself very much in need of more boiler capacity. Study of plans for enlargement included the proposal to adopt **Armstrong Individual Trapping.** 62 Armstrong traps went in and immediately the laundry had plenty of boiler capacity. IT PAID TO STOP THE LEAKS.

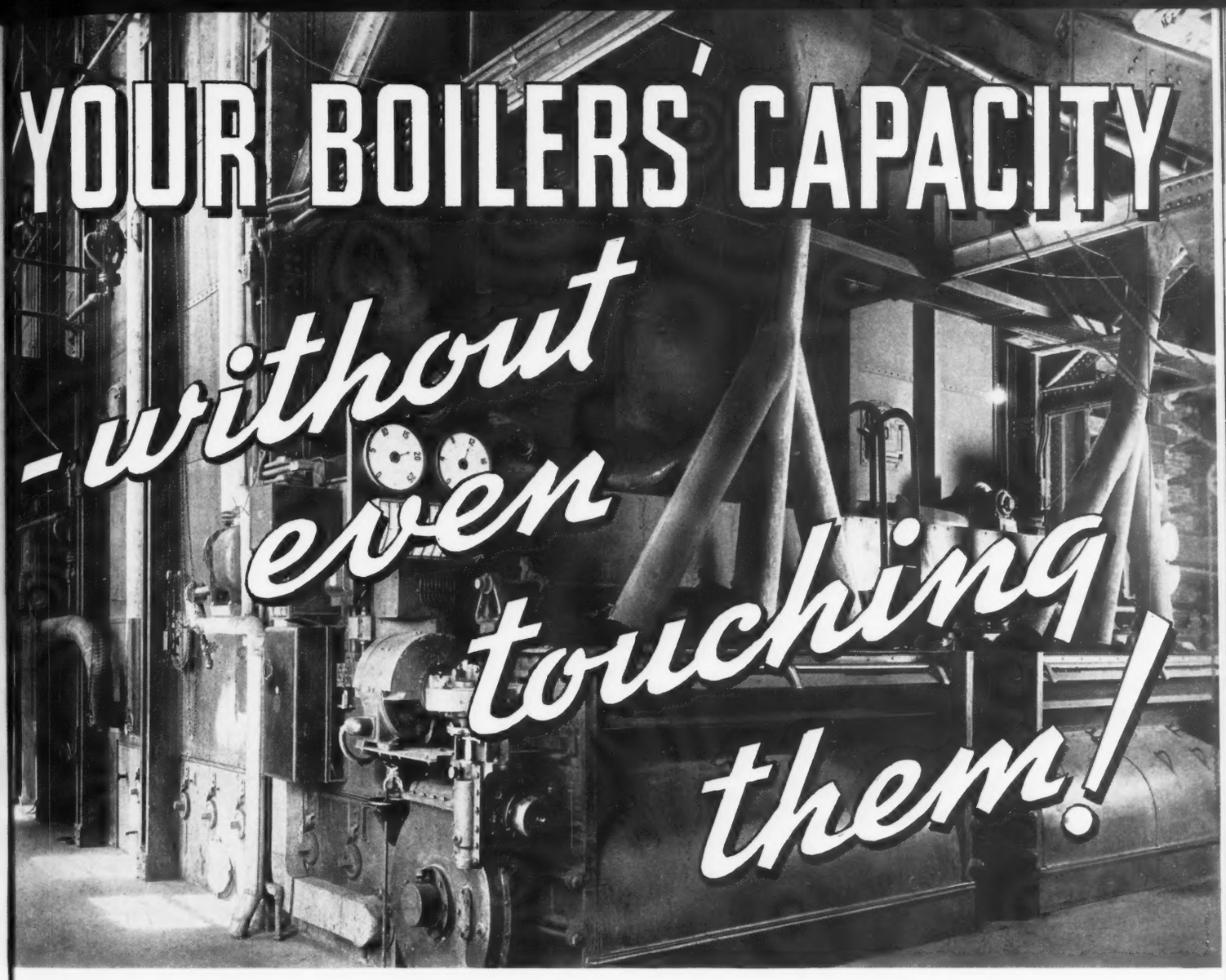


CERAMIC PLANT R. Thomas & Sons Co., Lisbon, Ohio, makers of porcelain insulators, put in 66 Armstrong traps to end exceptionally heavy maintenance costs. This the traps did with a fuel saving, besides. Where three boilers and 5000 lbs. of coal per day were formerly needed, two boilers and 3000 lbs. of coal now do the trick.

PUMPING STATION Thorough application of Armstrong traps for dripping headers and draining steam cylinder jackets also pays dividends in straight power service. By stopping leaks and raising efficiency, the Oil City Water Department at Oil City, Pennsylvania got a saving of $2,651.42 in one year. This new efficiency also means greater plant capacity.

CHEMICAL PLANT In one month, 17 new Armstrong traps installed at the Heineman Chemical Co., Crosby, Pa., are credited with saving 3,470,000 cu. ft. of fuel gas. This was equivalent to nearly 25% reduction in gas consumption. Another way to look at it is as a worthwhile addition to the boiler capacity of the plant.

ARMSTRONG



SOUNDS like magic doesn't it? But it's as simple as A—B—C: put in new Armstrong steam traps for all of your header drips . . . separators . . . heaters . . . coils . . . process equipment, etc., and you immediately get protection against loss of steam by leaks and blow-through. Some plants have actually found that it was taking one boiler just to keep the leaks going!

Right now you may not need extra boiler capacity but you surely can use the equivalent saving of operating with less fuel. In addition, Armstrong traps help you to cut maintenance costs and improve performance.

Armstrong traps are offered in a complete range of sizes for any pressure. And in each one you get the genuine inverted bucket, free-floating valve operating mechanism. There are only two moving parts . . . no narrow openings to wear or get clogged with dirt . . . no gage glasses to watch . . . nothing to adjust.

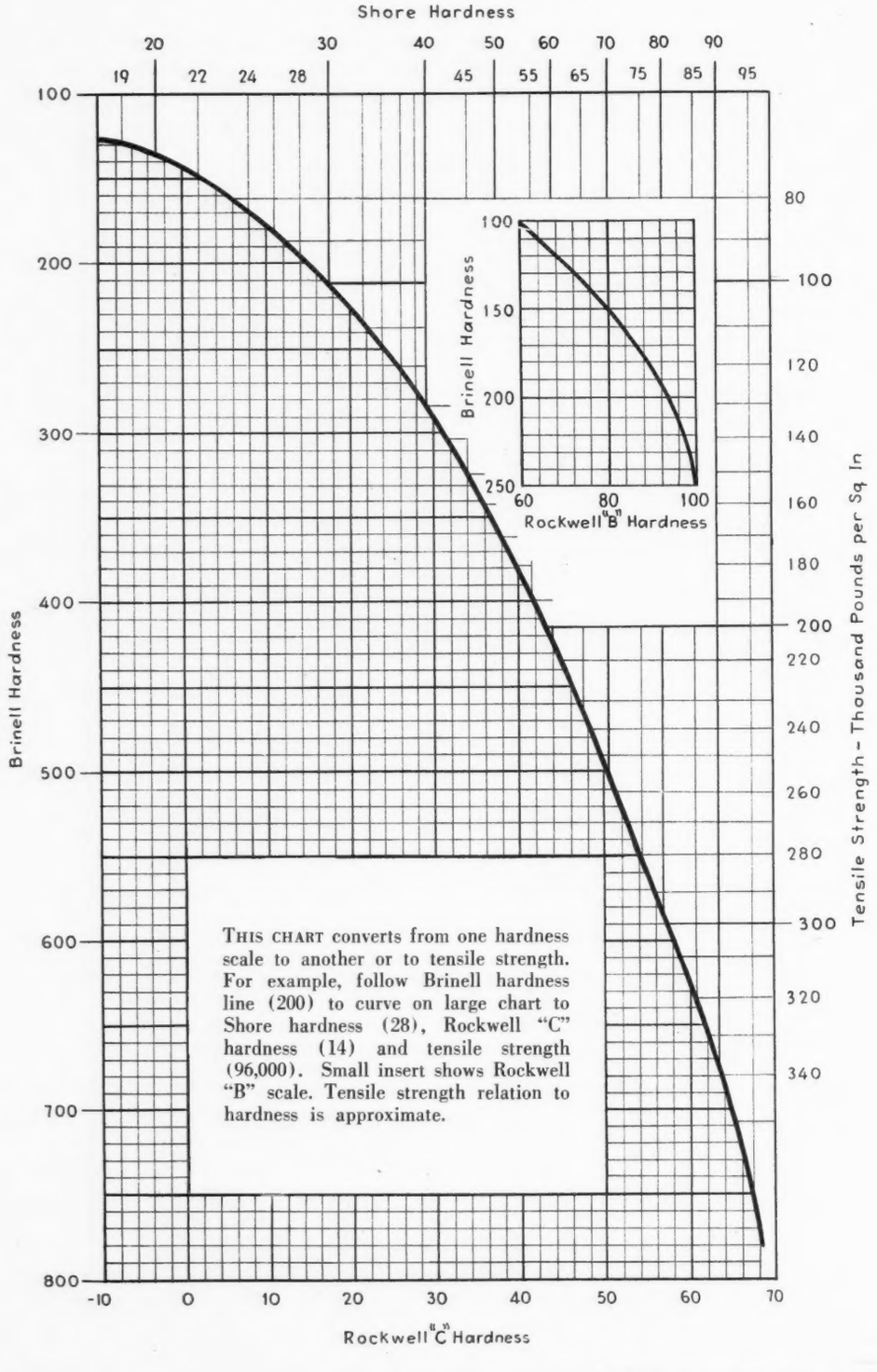
Ask for a copy of the Armstrong Steam Trap Book. It contains a wealth of information about piping, drainage, traps, etc. No obligation.

ARMSTRONG MACHINE WORKS,
812 Maple St., Three Rivers, Michigan.

STEAM TRAPS

Number 73

Hardness—Tensile Strength Conversion Chart


Shore Hardness
20 30 40 50 60 70 80 90
19 22 24 28 45 55 65 75 85 95
100 200 300 400 500 600 700 800
Brinell Hardness
-10 0 10 20 30 40 50 60 70
Rockwell "C" Hardness
80 100 120 140 160 180 200 220 240 260 280 300 320 340
Tensile Strength - Thousand Pounds per Sq In
100 150 200 250
Brinell Hardness
60 80 100
Rockwell "B" Hardness
THIS CHART converts from one hardness scale to another or to tensile strength. For example, follow Brinell hardness line (200) to curve on large chart to Shore hardness (28), Rockwell "C" hardness (14) and tensile strength (96,000). Small insert shows Rockwell "B" scale. Tensile strength relation to hardness is approximate.

Data Compiled by The International Nickel Co, Inc

© POWER

Dollars Flashed from Condensate

A simple change in handling high-pressure condensate saves $1250 and eliminates a troublesome humidity condition in the turbine room

By HENRY C NICHOLS
Chief Engineer, Danvers Bleachery, Peabody, Mass.

IN OUR power plant, vapor condensation on turbine-room and basement walls and window sills caused corrosion of metal window frames, deterioration of paint, and necessitated frequent check up of electrical equipment. Vapor was created by flashing of condensate from high-pressure drying apparatus, using 7000 lb of steam per hour at 200 lb pressure and 388 F. Condensate discharged into a surge tank, Fig. 1, which had a small vent pipe to atmosphere and an overflow pipe with a water seal leading to the turbine-room basement. At times, the vent could not handle all the vapor, causing the water seal to blow and admit vapor to the turbine room.

Steam Flow

Turbines, supplied with steam at 200 lb and 100 F superheat, exhaust into the low-pressure steam main to supply the mill with process steam at 10 lb. Inasmuch as 10-lb process steam requirements exceed amount of turbine exhaust, high-pressure steam supplements the exhaust to maintain a constant pressure at 10 lb. Originally, this high-pressure steam passed through a desuperheater which used water taken from the boiler-feed line and which was controlled by a thermostatic valve to obtain desired steam temperature. A trap removed condensation that accumulated in the bottom of the desuperheater.

Later, we discovered that certain processes in the mill would be improved by a small amount of superheat in the 10-lb process steam and at the same time there would be less condensation in the steam line. The desuperheater was then removed and the high-pressure line connected directly to the 10-lb line through the reducing valve.

A heating and ventilating engineer recommended installation of blowers to remove moisture-laden air and unit heaters to heat cold air entering the building. Cost of this installation ran into several hundred dollars, so the management decided not to act hastily. After a little more study, we found a relatively simple solution which also improved heat balance—using the desuperheater as a flash tank and connecting it as in Fig. 2. The high-pressure condensate line connects into the top of the flash chamber and extends down 3 ft inside the tank as indicated.

It was possible to make this change without relocating equipment. By substituting condensate-return pipe for the high-pressure-steam pipe and replacing the 1-in. high-pressure trap with 2-in. low-pressure one, we were able to complete the changeover without making any other changes. The low-pressure trap drains into the return line, which receives condensate from drying machines using low-pressure steam and is pumped into the surge tank, which also receives condensate from a closed heater and cold makeup water.

Part of the high-pressure condensate is now flashed into steam and goes into the 10-lb line. As all exhaust steam from the turbines is used and high-pressure steam from the boilers makes up any deficiency of exhaust, any reduction in high-pressure-steam consumption from the boilers is a direct saving in operation of the plant. About 4,500,000 lb of 10-lb steam per year is supplied from the flash tank, resulting in a saving in fuel cost of around $1250 annually, besides correcting our difficulties with condensation.

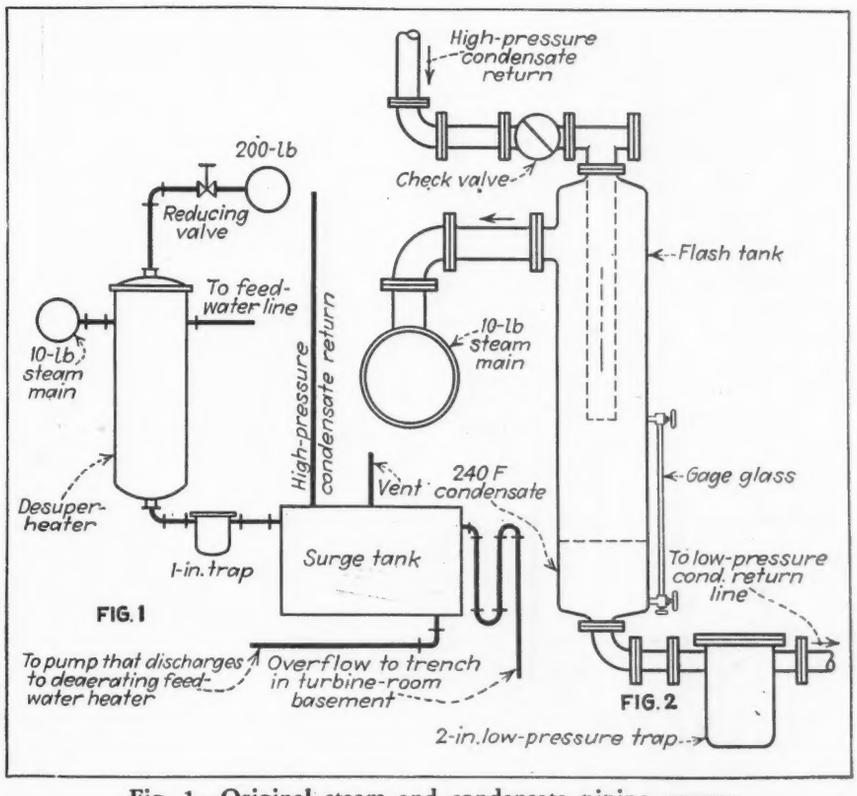
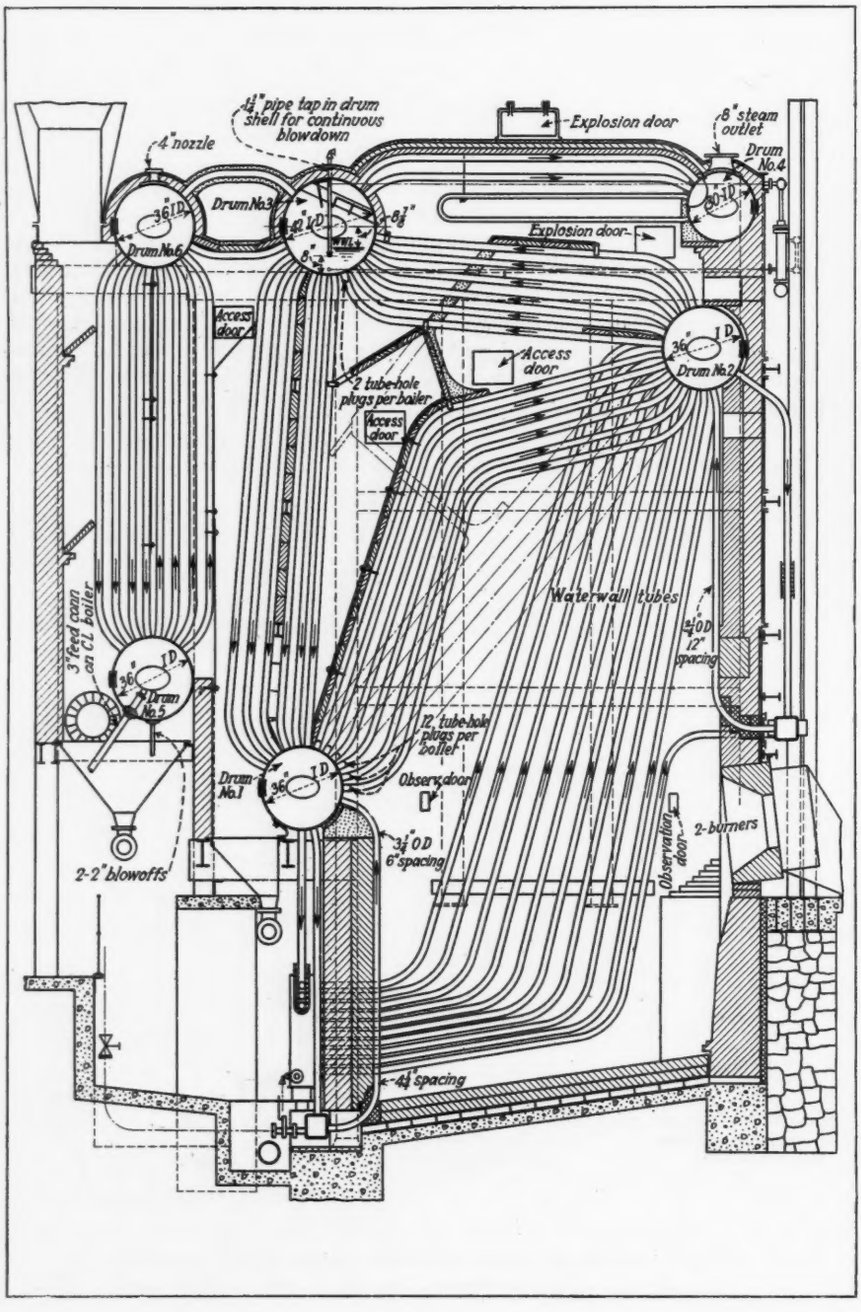


Fig. 1—Original steam and condensate piping connection. Fig. 2—Desuperheater converted into a flash tank

What Happened?

Why did steam temperature climb 150 F while steam flow, CO_2, and exit-gas temperature remained normal and furnace showed no unusual conditions?

By M H KUHNER
Chief Mechanical Engr, Riley Stoker Corp



OPERATORS of an industrial steam plant were mystified recently when steam temperature of a pulverized-coal-fired steam generator rose from 450 F to 600 F without change in steam flow, CO_2, or exit-gas temperature. That observation of the furnace showed normal conditions only increased the mystery.

Three boilers supply steam in this plant; one is rated at 150,000-200,000 lb per hr of 600-lb, 630-F steam, and the remaining two at 65,000 lb per hr of 170-lb, 450-F steam. The latter two were installed in 1921 with underfeed stokers and were revamped in 1934 by replacing stokers with pulverized-coal burners, increasing furnace volume, and adding a simple waterwall system. The cross-section shows the appearance of the revamped units.

On April 5, 1938, only one of the two modernized units was in operation. Five charts give data on its performance at that time, showing steam flow, CO_2, exit-gas temperature, steam temperature leaving superheater, temperature in low-temperature steam header, and temperature beyond pressure-reducing and desuperheating station tying high- and low-pressure systems together.

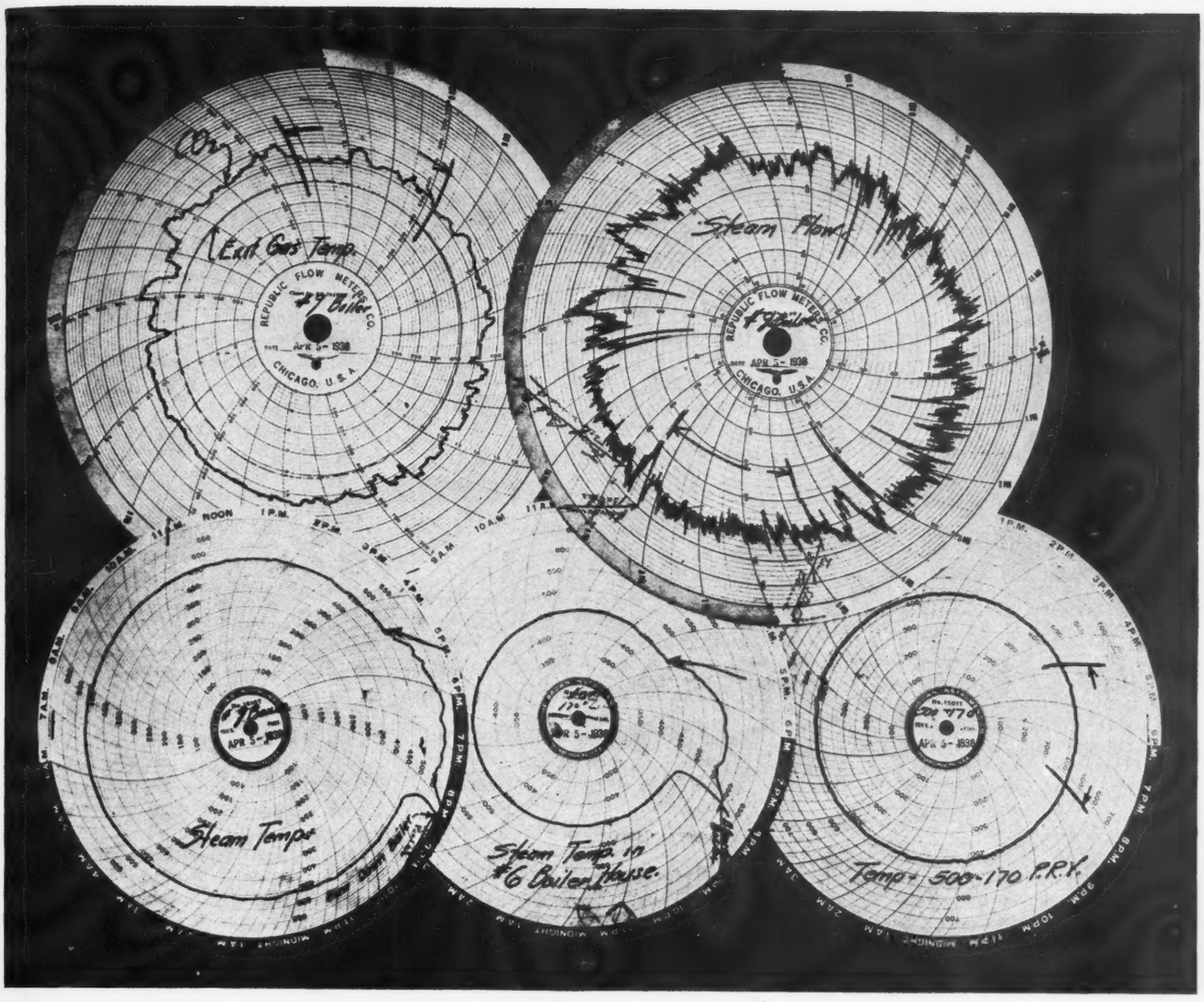
At 4:45 pm steam temperature from the low-pressure boiler began to climb above the 450-F mark, eventually reaching 600 F at 8:15 pm. Charts show no unusual changes in other factors. At 8:15 pm, steam temperature suddenly dropped to normal (aproximately 460 F), at which point it remained until the chart was removed. Oddly enough, the sudden drop in temperature coincided with blowing down the boiler.

A Double Mystery

Two things bothered the operators: (1) What produced this sudden rise in steam temperature, something that never happened before or since, and (2) was dropping of temperature as the boiler was blown down a coincidence, or did blowdown produce the drop?

Unusually high steam temperature sometimes results from delayed or secondary combustion occurring in the region of the superheater. This would be indicated by a rise in exit-gas temperature, however, and none was evident in this case. Another possibility was that flyash high in combustible content collected on the almost-horizontal baffle immediately below the superheater element (see cross section). In this way sufficient heat might have been developed in the superheater pass to raise steam temperature to an average of 560 F for the 3½-hr period in question.

It could not be assumed, however,



that soot on the horizontal baffle would suddenly stop burning, causing the drop in steam temperature from 600 F to 460 F. Soot blowers had not been operated. But vibration in the pressure system due to blowing down might have been sufficient to free the deposit on the baffle so that the current of combustion gas passing over it swept the baffle clean of fly-ash. This seemed to be the only answer to the second question.

Have *Power* readers had similar experiences? If so, what is their explantation?

✦ ✦ ✦

Questions for Boiler-Room Engineers

By Harry M Spring

Q—If segments between tubes in the rear tube sheet are found to be slightly bulged outwards, what is the probable cause, and what is the remedy?

A—Heavy scale or oil deposits on the inside of the rear tube sheet are the cause; cleanliness is the preventative.

Q—What is the practical allowed stress for braces in steam boilers?

A—Usually 7500-10,400 lb per sq in. for weldless steel braces. However this varies with different sizes and types and under different codes. Refer to your local code book.

Q—What would be the maximum height of the furnace fire line on an externally fired boiler?

A—The lowest safe water level should always be at least 3 in. above the fire line of an externally fired boiler. A greater distance is advisable in many installations.

Q—Should warm or cold water be used when making a boiler hydrostatic test?

A—Water at room temperature should be used (70-120 F). This test is run to determine the safety of a vessel. If hot water is used, it may flash into steam if any part fails. Also the expansion of parts filled with hot water may prevent leakage and conceal a defect. Cold water may cause slight leakage past caulking edges even though there be no defects.

Q—If you wanted to shut off a steam heating system would you first close the steam valve or the return valve?

A—The steam valve should be closed first to allow return of condensate, and to prevent water hammer when starting up.

Q—Will a boiler withstand a greater pressure when cold than when hot? Why?

A—Starting from room temperature, tensile strength of steel gradually decreases as temperature rises. Decrease is slight until high temperatures are attained, then strength falls off

Current Comment

More About Series Operation of Pumps

THERE IS no difficulty involved in operating two centrifugal pumps in series provided that the rated capacities of the pumps are nearly equal, as the net rate of flow through each pump must be the same in series operation, regardless of the heads. Without data on the performance of WML's pumps no definite answer can be given to his question on page 110, June *Power*. The following possibilities exist:

(1) **General case of series operation**—Given the characteristics of the pumps, the over-all performance for series operation can be determined by plotting characteristic curves at rated speed on the same sheet of paper for comparison. In general, the more closely the head capacity curves correspond, the more effective will be the operation. Next plot head-capacity curve for series operation by adding heads produced by each pump, at each capacity point. Don't carry this curve beyond the capacity of the smallest pump, for at greater capacities the smaller pump will act as a turbine. Combined efficiency will be the product of the efficiencies at any given capacity, and combined horsepower will be the sum of the separate horsepower. Determine operating point by plotting head-capacity curves for piping system in question—intersection with pump curve will be operating point (see diagram).

This method definitely establishes the performance of the series combination and shows graphically why the combination will not give the sum of the rated heads unless capacity ratings are nearly the same. The order of the pumps is more or less immaterial but if one has better packing glands than the other it should be used as the second stage. If there is a marked difference in efficiency the more efficient pump should be used in the second stage for losses increase silghtly when a pump of ordinary design is operated under pressure.

(2) **Correction for large differences in performance characteristics by changing speed of one or both pumps.** Performance of a pump may be entirely changed by altering its speed. Having the characteristics for rated speed, characteristics for other speeds may be closely predicted for speeds within 30% above or below rating, by application of the affinity relationships:

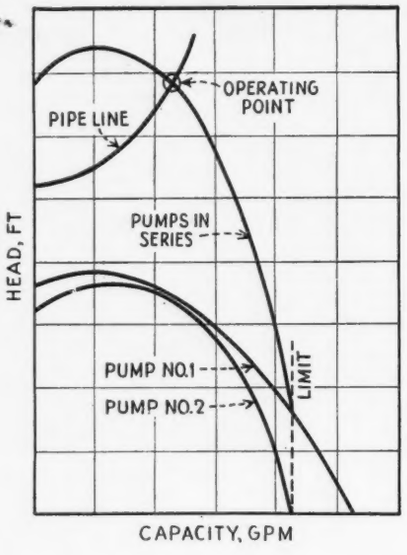
Capacity is proportional to speed.

Head is proportional to square of speed.

Horsepower is proportional to cube of speed.

Efficiency is independent of speed.

Taking a series of points on the given curve and applying these relationships to each coordinate of the points, curves for other speeds can be constructed. Applicability of changing speed depends on drives WML has available.



(3) **Use of bypass or throttling valve to decrease net discharge of one pump.** If one pump is rated at much higher capacity than the other, and if changing speeds cannot be applied, then the larger pump can be used as the first stage and a bypass or throttling valve on the outlet will bring its net discharge within the range of the other pump. Such an arrangement would require making a test to determine proper valve setting, and although it is perhaps the simplest solution, it cannot be expected to be the most efficient.

Oakland, Cal. H B NOTTAGE

Stuck Gage Causes Diesel Oil Trouble

WHEN WATER content of lube oil for a battery of three 400-hp diesels went up from a trace to an average of 1.5%, with some samples in the centrifuge showing more than 2%, it was time to look for trouble.

Careful checking proved that the leakage was jacket water, finding its way down between block casting and liner, and passing the pack-off ring at that point. As opportunity presented, one and then another of the units was taken off load, and cylinder liners were pulled to allow fitting of new rings. However, examination of the first liner pulled, as well as of those pulled later, showed that the packing in use was resilient and apparently should have served its purpose satisfactorily.

Before the third unit could be dismantled, the water again made its appearance on the first diesel, and again leakage was traced to the joint between block and liner. On this occasion, liners and engine castings were carefully "miked" on the theory that unequal expansion had taken place and left the packing ring insufficiently supported through an arc extensive enough to permit seepage. Dimensions checked absolutely with manufacturer's specifications so the unit was reassembled, again with new packing rings.

When leakage became evident for a third time, after two weeks of operation, the chief turned to the log instead of to the engine. Records were searched for a clue to the mystery. Only item of a non-routine nature was the fact that piping for the jacket-water pump had been renewed. The gage on this motor-driven pump read 20 lb, 5 lb lower than had been carried previous to the piping change.

Water lines to each engine were controlled by individual valves, regulated to maintain desired jacket temperature; water not used was bypassed through an adjustable spring-controlled valve to the pump suction. With attention focussed on the water system, the engineers all remembered that valves on the engines whistled when pinched down to maintain engine temperature, something that had not happened before.

With these clues pointing to the pressure gage, it was removed and checked with a deadweight tester at 5, 10, 15, and 20 lb, proving accurate. Again installed, it registered 20 lb line pressure with all units on—but maintained the same reading even when the bypass-valve spring was screwed down to boost the pressure. When tested again, the gage proved accurate up to 20 lb but refused to pass that point even when the dead weight was doubled.

Investigation showed a small chip lodged firmly in the segment of the gage at a spot where it would lock pinion and segment when the needle pointed to the 20 lb mark. This removed, the gage showed that the engines had been operated under a cooling-water pressure of 80 lb indicating that excessive circulation pressure had forced water past the packing rings, with consequent oil pollution. The chip must have gotten in when the gage was removed for the piping change; rules now require opening the case and checking the mechanism, plus a routine deadweight test, whenever the gage is handled.

Kilgore, Texas C C LYNDE

What Is an Engineer?

I WAS INTERESTED in the letter by Harry M Spring, appearing in May *Power* on "What Is an Engineer?" Especially so, as I have from time to time taken part in the preliminary work connected with laws applicable to professional engineers.

As my experience in this line extends only to New Jersey and New York, anything which I may say applies definitely to these states, although I believe that conditions in most others are similar.

There has been some talk about the advisability of confining the title of

engineer to licensed professional men. Such a restriction is, in my opinion, not only impracticable, but unreasonable, and it would appear that the present laws adequately deal with the matter, for they state that one may neither practice, nor offer to practice professional engineering without a license. It would therefore appear reasonable to suppose that the use of such terms as consulting engineer, professional engineer, or any other which would indicate that the unlicensed man was claiming to be a professional engineer, under the act, would be prohibited by the courts.

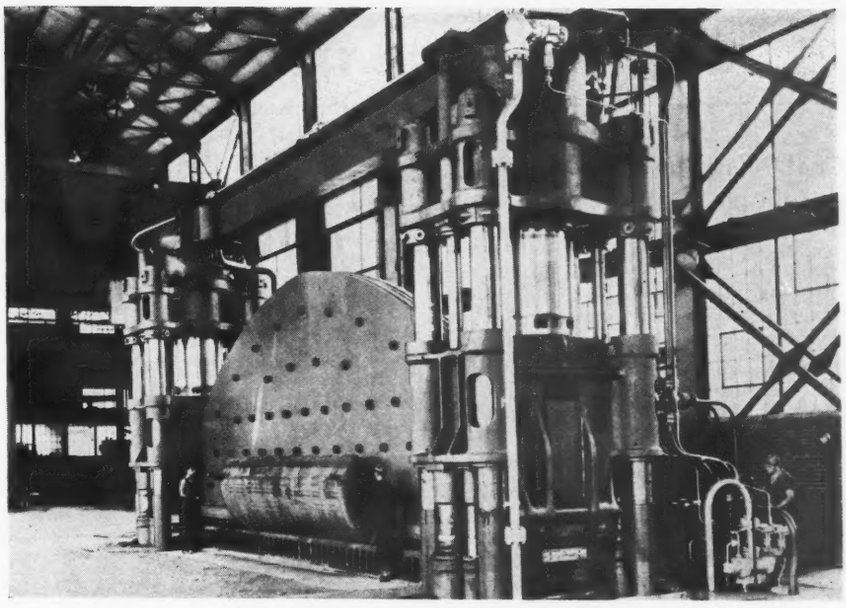
The first thing that impresses one when considering the development of licensing laws, is the fact that practically all professions and many trades are going in for licensing. Like it or not, if your own profession is not represented in this group, you will probably find yourself in a tight corner. The first thing that anyone does when he attempts to draw up legislation, along these lines (I have done it myself) is to see how many things he can list which he will be permitted to do, and how few things the other man is to be allowed to do, so by the time all the first comers have had their turn, there is not much left for anyone else.

A good example of this is the architect, who was first in the field, and apparently has a blanket license to do everything under the sun. In the states above referred to, there is a clause in the law exempting licensed architects from the provisions of it, so presumably the architect can call himself any kind of an engineer he pleases while the engineer cannot call himself an architect.

It was to even out this inequality to some extent that the engineers of New York agreed that their licensees should be examined in structural design provided that they were accorded the same privileges as architects with regard to designing buildings.

A certain amount of politics is unavoidable in connection with all special legislation such as the licensing of engineers, for no matter what you do, other professions and interests will be affected. It is quite reasonable that they should have their day in court, and do what they can to protect their own interests. Consequently all such legislation must be more or less a compromise. This is one difficulty which confronts attempts to make the laws in different states uniform.

In the State of New York, the professional engineer has a blanket license. In the State of New Jersey, an attempt is made to define what kind of an engineer he is supposed to be. Whether this can legally limit his practice is so far an open question. If the courts should hold that it does, it is going to be just too bad for us, for no one can practice one branch of engineering without at times, encroaching on others. I don't believe that any man can define in a legally valid manner, the boundaries of any particular branch of engineering, which leaves the field wide open for endless litigation.



BOILER BENDER

Hedges-Walsh-Weidner Div of Combustion Engineering Co, Inc, at Chattanooga, Tenn., has installed what is said to be the largest and most powerful boiler-plate bending press ever built. Two main rams, each 50 in. in diameter, operate with water pressure of 1500 lb per sq in., or if the intensifier is in operation, at a pressure of 3000 lb per sq in. On each side are four push-back rams for highspeed work and under the bottom die are four manipulating rams. Equipment extends 22 ft below the floor; from top of cylinder to floor is 27 ft

I quite agree with the statement of the personnel director mentioned by Mr. Spring that licenses are not of much interest to the average employer, though it would be very much to our advantage if we could make them more so. The lawyer, the doctor, and the certified public accountant seem to be able to benefit by the fact that they are legally qualified to practice their professions, even though they may be employed on a salary. Why should we not be able to do something to improve our professional standing?

Bloomfield, N. J. J O G GIBBONS
Consulting Engineer

Scale Removal or Safe-Ending?

IN A PLANT I visited recently, I learned that the boiler tubes had just been taken out of a 1500-sq ft hrt boiler and replaced. A boiler inspector had looked the boiler over and had found about ⅛-in. scale on the tube surfaces. His recommendation was for the engineer to remove the tubes, have them scraped or cleaned mechanically, a piece welded on the end to make them long enough to fit the boiler again, and replaced in the boiler.

In ten years around boilers I have heard of only one such move and that was welding patches on tubes which had been burned and blistered through inefficient feedwater treatment. Personally, I don't think boiler inspectors of this calibre should be allowed to inspect other people's property. In this case, a knocker or a turbine would have efficiently removed the scale at considerably less cost, or a reliable feedwater treatment manufacturer recommended to clean the scale from these surfaces.

I would like comments on this from other engineers.

S Birmingham, Ala. PAUL E RUDBECK

Editor's Note—To get the other side of the story we sent Mr Rudbeck's letter, with his permission, to Harry M Spring, a boiler inspector of long experience. Here is his reply:

FROM MR RUDBECK'S description of the repairs made to the 1500-sq ft hrt boiler, I suspect that the prime reason for ordering the tubes removed was not for scraping off scale. It is not an uncommon occurrence in a fire-tube boiler for the tubes to become reduced in thickness for several inches at the ends entered by the products of combustion. Erosion and abrasion by particles of soot and ash are the principle causes of this condition. A coating of scale on the water surfaces would cause the tube to rise to a high temperature, especially at the fire end. Thus, resistance of the metal to abrasion would be less and deterioration would proceed even more rapidly.

Often the tube ends become dangerously thin. Collapse of a tube is not an uncommon result. Thus, when an inspector finds tube ends greatly reduced in thickness, he is justified in ordering immediate and thorough repairs. In many cases, the tubes may be thin at the fire ends, but the remainder may be in good condition. In the case mentioned by Mr Rudbeck, the coating of scale very likely protected the tubes from corrosion or

(*Continued on page* 116)

Power Lines

Coal Men Meet in Chicago, Oct 13-15

Coal engineers and operators will meet in Chicago, Thursday, Friday and Saturday, Oct 13-15, at the Palmer House. The meeting, centering on recent developments in producing and preparing coal for industrial and home use, is jointly sponsored by the ASME (Fuels Div), the American Institute of Mining & Metallurgical Engineers (Coal Div), and the Western Society of Engineers.

Papers outlined for the general sessions will cover stokers, coals for steam generation and domestic use, coal hydrogenation, strip-mine equipment, screening and materials handling in coal-preparation plants, effects of coal-ash properties, underground mechanization and ventilation, etc. Much is expected of a projected panel discussion by four authorities, each handling a different phase, regarding purchasing of coal.

ASME Forms Committee on Rubber and Plastics

The American Society of Mechanical Engineers has recently established a committee, or subdivision, on rubber and plastics, to include mechanical applications, research on basic mechanical properties, processing equipment, and standards. Activities of the group will go beyond the normal range of other professional organizations in an effort to fill the present gap in the mechanical field.

Hydro Project Awards

The Allis-Chalmers Manufacturing Co has been awarded a $700,000 contract for four 20,000-hp hydraulic turbines for the Grand River project in northeastern Oklahoma. Contract includes governors and one 750-hp service unit.

At the same time the company was notified that it was low bidder on waterwheel generators for the Chickamauga Dam on the TVA development. Contract will amount to between $1,000,000 and $1,500,000, it is reported, according to the number of generators the government decides to take.

Unwin Memorial

Friends, associates and past students of the late Dr W C Unwin are engaged in raising a fund to amplify the endowment for the Unwin Scholarship awarded annually by the Central Technical College, London, and to provide a suitable memoir of Dr Unwin's life.

Dr Unwin was a world figure in engineering and education. He was a leading authority in many branches of engineering, including hydraulics, pneumatics, gas distribution, steam-power engineering, bridge construction, design of masonry dams, strength and testing of materials, and machine design. In the U. S., he was well known for his work on the International Niagara Commission and for his textbooks.

Contributions may be sent to E G Walker, honorary treasurer, Unwin Memorial Committee, 82 Victoria St, London S W 1, England.

OBITUARIES

FRANK J TUITE, a member of the Engineering and Sales Departments of Robins Conveying Belt Co for more than 25 years, died July 20.

ARCHER E DAVIDSON, well known steam engineer, died July 7 after a brief illness. Born in Farmsville, Va., Mr Davidson was graduated from Virginia Polytechnic in 1902. Immediately after graduation, he joined Westinghouse Electric & Mfg Co in Atlanta, Ga., where he worked until transferred to Westinghouse's Boston office. At the time of his death, Mr Davidson was head of the Steam Engineering Division in New England.

HENRY LAIDLAW, 78, widely known in the pumping-machinery field, died in Kingsville, Ontario, Canada on June 25. Mr Laidlaw was born in Scotland and came to the United States in 1880. In 1887 he joined his brother Walter Laidlaw, one of the founders of Laidlaw-Dunn-Gordon Air Compressor Co, and became first salesman for the new company, traveling throughout the Middle West. When the International Steam Pump Co was formed in 1898, of which Laidlaw-Dunn-Gordon Co was a member, he became sales manager of this company's Detroit office, and also for its successor, Worthington Pump & Machinery Corp.

E GORDON CAMPBELL, mechanical operating engineer, Power Stations Dept of Duquesne Light Co, died June 23. Mr Campbell was born in Charleston, S.C., and was graduated from Clemson College. First employment was with General Electric at Schenectady for three years; thereafter for two years in Panama with the Isthmian Canal Commission in charge of electrical construction and operation. After returning from Panama, he was in charge of engineering and construction on many large power projects, until 1926 when he joined the Duquesne Light Co. Mr Campbell was a member of the N.Y. State Society of Professional Engineers and the ASME.

BUSINESS ITEMS

REVERE COPPER & BRASS, INC, has opened a new branch office at 915 Second National Bank Bldg., Houston, Tex. Hans O Howard, formerly of the Dallas, Tex. office, will be in charge.

MASON-NEILAN REGULATOR CO, Boston, Mass., has opened an office at 3007 Detroit Ave, Toledo, Ohio, headed by Paul Condit.

HILLIARD CORP, Elmira, N.Y., has ap-

MATERNITY WARD

Delivery room at General Electric's Schenectady works where five steam turbine-generator sets (total capacity 140,000 kw) are being erected for test. About ten months are required to each of the sets; then four more months are spent in testing them before they are disassembled and shipped

Meetings

American Society of Mechanical Engineers—*Fall Meeting, Oct 7–9, Biltmore Hotel, Providence, R. I. C E Davies, secretary, 29 W 39th St, New York, N. Y. Also, ASME annual meeting, Dec 5–9, New York, N. Y.*

ASME and AIMME Coal Conference—*Joint Meeting, Oct 13–15, Palmer House, Chicago, Ill. C E Davies, secretary, 29 W 39th St, New York, N. Y.*

Association of Iron and Steel Engineers—*Annual Convention and Iron and Steel Exposition, Sept 27–30, Cleveland, Ohio. Brent Wiley, managing director, Empire Bldg, Pittsburgh, Pa.*

American Welding Society—*Annual Meeting (in conjunction with Metals Congress Exposition), October 17–21, Detroit, Mich. M M Kelly, secretary, 33 W 39th St, New York, N. Y.*

National Exposition of Power and Mechanical Engineering-*Dec 5–10, Grand Central Palace, New York, N. Y. Charles F Roth, manager, International Exposition Co, New York, N. Y.*

Technical Association of the Pulp and Paper Industry—*1938 Fall Meeting, Sept 8–10, Northland Hotel, Green Bay, Wis. R G MacDonald, secretary, 122 E 42nd St, New York, N. Y.*

pointed Bleckley & Walsh, 401 Volunteer Bldg, Atlanta, Ga., as representative for oil-reclaiming equipment in Georgia, Florida and Tennessee.

CLEAVER-BROOKS Co, Milwaukee, Wis., has moved its executive and engineering offices to 3112 W Center St, next to its factory on N 332nd St.

UNITED CONVEYOR CORP, Chicago, Ill., has appointed T E Nott, Charlotte, N.C., as exclusive agent in North and South Carolina.

PERSONALS

WILLIAM W BOND has been appointed western sales manager of Link-Belt Co's Positive-Drive Division, with headquarters at the Dodge plant in Indianapolis, to succeed G H Burkholder, deceased.

VICTOR A HANSON, vice-president and chief engineer of the Power Transmission Council, has been transferred to Detroit, where he will conduct an extensive survey of power problems in manufacturing plants identified or closely connected with the automotive industry.

DR JOSEPH SLEPIAN, who as a young doctor of philosophy abandoned a promising career in pure mathematics to wind coils for electric motors, has been appointed associate director of the Westinghouse Research Laboratories in East Pittsburgh, Pa. Despite the fact that his formal education in higher mathematics included nothing about electrical engineering, Dr Sepian has become a well known electrical engineer. His inventions helped make possible distribution of electric current at the present peak of 280,000 volts by providing a new method of breaking up electric arcs.

HENRI P PANET, widely known in Canadian power circles and associated with the beginnings of electric power in Montreal, retired on pension July 1 from his position as superintendent of the Chambly Power Station in Montreal. Rodolphe Bettez, who has been chief operator of Chambly since 1935, succeeds Mr Panet.

SVEND A CANARIIS, formerly waterworks engineer with Westinghouse Electric & Mfg Co, has accepted a similar position with Pomona Pump Co, Pomona, Cal. Mr Canariis, born and educated in Denmark, came to the U.S. in 1922. Since then he has been electrical

designer for Alabama Power Co, senior electrical engineer in the sales engineering dept of Duquesne Light Co in Pittsburgh, and electrical engineer for the Pittsburgh water department. In his new position, Mr Canariis will make his headquarters in Pittsburgh and do special application engineering in the eastern states and foreign countries.

WILLIAM J DALY, formerly Detroit district sales manager for Worthington Pump and Machinery Corp, has been transferred to the corporation's Philadelphia office to succeed C H Shaw, deceased. Mr Daly will be succeeded by W J Van Vleck, recently appointed assistant manager, in the Philadelphia district.

GEORGE L DAVIS has been appointed vice-president in charge of sales of The Diamond Power Specialty Corp, Detroit, Mich.

ANDREW H PHELPS has been appointed general manager of purchases and traffic for the Westinghouse Electric & Mfg Co, according to an announcement by

GEORGE M BUCHER, president. T J PACE, formerly general manager of purchases and traffic, has been appointed assistant to the vice-president. Mr Phelps went to Westinghouse in January, 1937, from the McGraw-Hill Publishing Co.

I H SCLATER has been appointed managing engineer of the Power Transformer Dept of General Electric's Pittsfield works, in which capacity he will have charge of both engineering and manufacture of GE power-transformer equipment.

STRAWS

Pointing the way business winds blow

ALASKA——Valdez plans municipal power plant, using diesel-generator units. Cost about $72,600. Financing through Federal aid. E M Stewart, Fairbanks, Alaska, consulting engineer.

ARIZONA——Benson plans municipal gas-distributing system. $35,000 has been secured through Federal aid. Work scheduled to begin soon.

ARKANSAS——El Dorado plans municipal power plant of about 3000-kw capacity, using diesel-generator units. Cost about $660,000. Financing concluded through Federal aid and work scheduled to begin soon.

CALIFORNIA——Board of County Supervisors, Los Angeles, plans power house for central-heating service. Cost $54,570,000. Financing through Federal aid. William Fox, county planning engineer; R E Shonerd, county mechanical engineer.

Procurement Division, Public Buildings Branch, Department of Justice, will award contract soon for power house at Federal penitentiary at Alcatraz. New boiler units, pumps and other equipment will be installed.

COLORADO——La Junta will award contracts soon for three diesel-generator units for municipal power plant, 1750-hp, 1250-hp and 1000-hp respectively. Also for complete auxiliary equipment and power station building, 77 x 80 ft. Cost over $500,000, with distribution system. E T Archer & Co, New England Bldg, Kansas City, Mo., consulting engineer.

FLORIDA——Arcadia plans municipal power plant. Cost over $100,000. Financing through Federal aid. Work scheduled to begin in fall.

West Florida Co-operative Assn, Marianna, plans power plant for rural electric system. $300,000 being secured through Federal aid for entire project.

Kissimmee plans extensions in municipal electric plant and waterworks pumping station, including additional equipment. $80,000 being arranged through Federal aid.

GEORGIA——Dixie Asphalt Products Co, Savannah, plans power house at new local plant for manufacture of roofing products. Cost about $200,000. Work will begin soon.

Thomaston Ice Co, Thomaston, operated by Alvah Nelson Lumber Co, Thomaston, plans early rebuilding of portion of ice-manufacturing plant, recently destroyed by fire. Loss about $25,000, with equipment.

Dawson is considering butane-gas plant and system. Cost about $60,000. Financing through Federal aid.

Water Dept, Atlanta, plans electric-operated pumping equipment at Hemphill pumping plant, with capacity of 40,000,000 gpd. Also will install boiler units and accessory equipment at Hemphill and River pumping stations, and replace considerable old electrical equipment at Hemphill plant. Work will be carried out in connection with improvements in water system to cost about $450,000. W Zode Smith, president, waterworks committee, in charge.

INDIANA——Goshen plans extensions in municipal electric plant, including new

diesel-generating unit and accessory equipment. Cost about $90,000. Financing through Federal aid.

Rushville plans improvements in municipal electric plant. Cost about $180,000. Financing through Federal aid. James Caldwell, superintendent at station.

IOWA——State Board of Education, Des Moines, plans improvements in water plant and steam-transmission system at State College of Agriculture, Ames, including four vacuum pumping units, centrifugal pumping machinery, filter equipment, steam mains, etc. $91,200 has been secured through Federal aid. Work scheduled to begin soon.

State Board of Control, Des Moines, plans extensions in power houses at a number of state institutions, with installation of new boilers and auxiliary equipment as follows: State Hospital, Independence, cost about $36,000; State Penitentiary, Fort Madison, cost about $48,000; State Sanatorium, Oak Dale, cost $19,500; Boys' Training School, Eldora, cost $17,500; State Hospital, Mount Pleasant, cost about $24,000.

Ames plans extensions in municipal electric plant, including new turbine-generator and auxiliary equipment. Financing through Federal aid.

Ackley plans improvements in municipal power plant. Cost about $20,000. Financing through Federal aid.

Cascade has authorized employment of consulting engineer to prepare plans and estimates of cost for new municipal electric plant. Proposed to use diesel-generating units and accessories. Financing through Federal aid.

Larchwood contracted Electrical Engrg & Const Co, 1225 Walnut St, Des Moines, for equipment for municipal electric plant. Contract covers new diesel-generator set, switchboard and accessories. Cost about $26,000. Buell & Winter Engrg Co, Insurance Exchange Bldg, Sioux City, consulting engineers.

KANSAS——Florence plans municipal power plant, using diesel-generator units and accessory equipment. Cost about $85,000. Financing through Federal aid. Hefling & Hunter, E Second St, Hutchinson, consulting engineers.

Burlington plans extensions in municipal power plant. Estimates of cost are being made. Financing through Federal aid. Paulette & Wilson, 1006 Kansas Ave, Topeka, and Farmers' Union Bldg, Salina, consulting engineers.

Hillsboro plans municipal gas-distributing system. Cost about $50,000. Financing through Federal aid. Hefling & Hunter, E Second St, Hutchinson, consulting engineers.

St Johns plans municipal electric plant, using diesel-generator units and accessories. Cost about $75,850. Financing through Federal aid. Hefling & Hunter, E Second St, Hutchinson, consulting engineers.

KENTUCKY——Board of Trustees, Kentucky State Industrial College, Frankfort, plans power house at institution. $250,000 being arranged for this and other buildings at college. Leo Oberwarth & Son, Frankfort, architects.

LOUISIANA——Rayne plans improvements in municipal power plant and waterworks station. Bids will be asked soon. Cost about $84,900. Financing has been concluded through Federal aid.

Hodge-Hunt Lumber Corp, Ruston, plans boiler house in connection with new local planning mill. Site has been secured near city limits. Cost about $55,000.

MASSACHUSETTS——Boston Edison Co, 39 Boylston St, Boston, contracted Alphons Custodis Chimney Construction Co for radial brick stack, 138 ft high at power house at 776 Summer St, South Boston, and work will begin at once.

MICHIGAN——Mount Pleasant plans municipal power plant. Federal grant of $218,000 has been secured and additional funds will be arranged through bond issue at election on Sept 13. Proposed to ask bids soon.

O & S Bearing Co, 303 South Livernois St, Detroit, plans power house at new

(*Continued on page* 120)

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ala., Scottsboro—City, c/o J. W. Woodall, mayor, plans constructing electric power system. To exceed $150,000.

Calif., Mare Island—Yards & Docks, Navy Dpt., Wash., D.C., plans constructing power plant, Mare Island Navy Yard. $425,000. P.W.A. allotted grant.

Fla., Jacksonville—City, E. E. Anders, comr., plans constructing power improvements. $2,503,000. P.W.A. allotted $1,125,000 grant. M. Lee Elliott, Inc., 415 Tampa St., Tampa, engr.

Ia., Spirit Lake—Bd. Educ. plans constructing heating plant improvements and new equipment in school auditorium. $16,800. O. Thomas, Des Moines Bldg., Des Moines, engr.

Ia., Wilton Junction—Bids Aug. 22, by town, F. H. Miller, clk., constructing addition and improvement to municipal electric light and power plant, incl. Diesel engine, new switchboard panels, voltage regulator and engine auxiliaries. $25,000.

Kan., Coffeyville—City plans constructing general improvements to present power plant. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

Kan., Girard—City plans remodeling and new plant equipment to present electric light plant and additions to electric lines through county to serve customers in county. $250,000. E. T. Archer & Co., 609 New England Bldg., Kansas City, Mo., engrs.

Kan., Larned—City plans constructing power plant improvements. $100,000. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

Kan., Ottawa—City, c/o City Clerk, soon takes bids power plant improvements, incl. one 4,000 kw. turbo-generator, 2 boilers and all auxiliaries. Est. about $150,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., engrs.

Kan., Winfield—City plans constructing new municipal power plant. $175,000. Black & Veatch, 4701 Bway., Kansas City, Mo., engrs.

Mass., Brighton—Bids Aug. 16, by Treas. Dpt. at office Sup. Archt., Wash., D.C., constructing 13 buildings, incl. main hospital, staff building, power plant, garage, laundry, etc. Warren St., Commonwealth Ave. and Monastery Rd. $2,100,000. L. A. Simon, Federal Bldg., Wash., D.C., archt.

Minn., Pipestone — Bureau Indian Affairs, Interior Dpt., Wash., D.C., plans improving heating plant, $68,900. P.W.A. allotment approved.

Minn., Westbrook—City making plans constructing municipal power plant. $67,272. P.W.A. allotted $30,272 grant. Buell & Winter Eng. Co., 508 Insurance Exchange Bldg., Sioux City, Ia.

Minn., Worthington—City making complete surveys for constructing municipal power plant. $75,000 (not official). R. D. Thomas, 1200 2nd Ave. S., Minneapolis, engr.

Miss., Meridian—City plans constructing electric distribution system $620,000; power plant $500,000; electrification and pumping plant $15,000. Total cost $1,141,000. P.W.A. allotted $780,000 loan and $638,182 grant. Lide & Adler, 905 Woodward Bldg., Birmingham, Ala., engrs.

Mo., Columbia—City, c/o Mayor, making plans constructing addition to municipal light and power plant and necessary equipment. P.W.A. allotted $488,250. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Neb., Schuyler—City plans constructing power plant improvements. To exceed $25,000. Black & Veatch, 4706 Bway., Kansas City, Mo., engrs.

N. J., Trenton—Joseph Stokes Rubber Co., 220 Taylor St., M. H. Martindel, vice pres., secy.-treas., plans purchasing new boilers, stokers and other equipment for power house. Total cost $65,000.

N. Y., Bath—Bath Electric & Gas Comn., Bath, A. J. Hamilton, chn., plans constructing addition to power house and installing two 300 kw. new diesel powered generators. $50,000 incl. equipment. Maturity soon.

N. Y., Saranac Lake—Village, Village Hall, plans constructing municipal power plant. Est. $500,000. P.W.A. allotted $225,000 grant. M. S. Johnson, village engr. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

N. Y., Warwick—Bids Aug. 25, by Dpt. Social Welfare, 112 State St., Albany, repairing boilers, settings, power plant equipment, etc., at State Training School for Boys, $8,800; constructing and electrical work for incinerator at same building, $5,000. W. E. Haugaard, State Bldg., state archt., and T. F. Farrell, ch. engr., both State Bldg., Albany.

N. C., Chapel Hill—University of North Carolina plans constructing water works and electric power system. $306,500. P.W.A. allotted $137,925 grant. Atwood & Weeks, Durham, engrs.

N. C., Farmville—City plans constructing power plant additions $92,480, and water and sewage treatment plant $19,796. Total $177,275. P.W.A. allotted $79,774 grant. J. B. Lewis, mayor.

O., Cleveland—City, F. O. Wallens, dir. P. Utilities, allotted $2,457,639 P.W.A. grant for constructing electric light plant. $5,461,420.

O., Cleveland — Dpt. Welfare, Columbus, plans installing boiler and engine generator unit at Hawthornden, an adjunct to Cleveland State Hospital. M. Allman, dir. State Legislature appropriated $100,000 funds.

O., East Liverpool—City election Nov. 8, to vote issuance $1,500,000 mortgage bonds for constructing municipal power plant.

O., Newton Falls—City, C. R. Finical, clk., plans constructing electric light plant. $205,000. P.W.A. allotted $92,250 grant. Bryan & Sigman, Newton Falls, engrs.

O., Piqua — City, W. E. Buechner, mgr., plans constructing addition to municipal electric power plant, incl. new boiler unit and 4,000 kw. unit. $200,000. Burns & McDonnell Eng. Co., 107 West Linwood St., Kansas City, Mo., engrs.

Okla., Blackwell—City plans constructing power plant extensions incl. new turbine, cooling plant, switchboard and distribution improvements $350,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., engrs.

Okla., Chelsea—City voted bonds for constructing unit at present municipal electric plant, will also add new switchboard and power wiring. $25,000. W. B. McMasters, 1724 Northwest 9th St., Oklahoma City, engrs.

Okla., Claremore—City made preliminary plans for purchasing additional engine for its power plant. $45,000. B. Sprankle, Clarmore, engr. E. A. Church, mayor.

Okla., Drumright—City made sketches constructing municipal light and power plant and electric distribution system. $250,000. V. V. Long & Co., Colcord Bldg., Oklahoma City, engrs.

Okla., Prague—City sketches made for constructing municipal light and power plant and new electric distribution system. $100,000. W. R. Holway, Tulsa, engr.

R. I., Newport—Bids Aug. 10, Yards & Docks, Navy Dpt., Wash., D.C., two 750 hp. watertube boilers with air cooled boiler settings and water walls, mechanical stokers, steam-turbine driven forced and induced draft fans, steel stack, air and flue gas ducts, boiler appurtenances and piping to point indicated, all to be installed at the Naval Torpedo Station, Spec. 8828.

S. C., Orangeburg—Orangeburg-Aiken Hydro-Electric Comn., J. M. Green, chn. and secy., making preliminary survey for hydro-electric plant on Edisto River. $1,000,000. D. T. Duncan, Ninety-Six, engr.

Texas and New Mexico—Bureau Reclamation, Denver, Colo., allotted P.W.A. funds for Elephant Power Plant, 24,000 kva. capacity, Rio Grande Project, Texas and New Mexico. $1,000,000. Competitive bidding.

Tex., Austin—Lower Colorado River Authority, c/o F. Englemann, ch., Littlefield Bldg., making plans constructing dam improvements, incl. rural power and light lines in approximately 7 counties. $7,350,000. $4,500,000 loan and $2,850,000 grant allotted. C. McDonough, Littlefield Bldg., engr.

Tex., Wichita Falls—City, c/o J. Bryan, mayor, plans constructing municipal power and light plant, incl. all necessary equipment, machinery and distribution system, etc., four 2,000 kw. Diesel electric generators, street lighting system. $1,750,000. P.W.A. loan and grant allotted. Engineer, c/o owner, engr.

Va., Covington—Municipal Electric Utility Comn., plans constructing power house, and 2,000 kw. electric generating station, distribution system, street lighting facilities, traveling crane and 2 stoker steam boilers. $402,365. P.W.A. allotted $181,636 grant. Wiley & Wilson, Amer. Bldg., Richmond, consult. engrs.

Ontario—Dr. T. H. Hogg, chn. Hydro-Electric Power Comn. of Ontario, Toronto, soon takes bids general construction activities in southern Ontario $7,500,000; new work in northern Ontario, $2,500,000. Private plans.

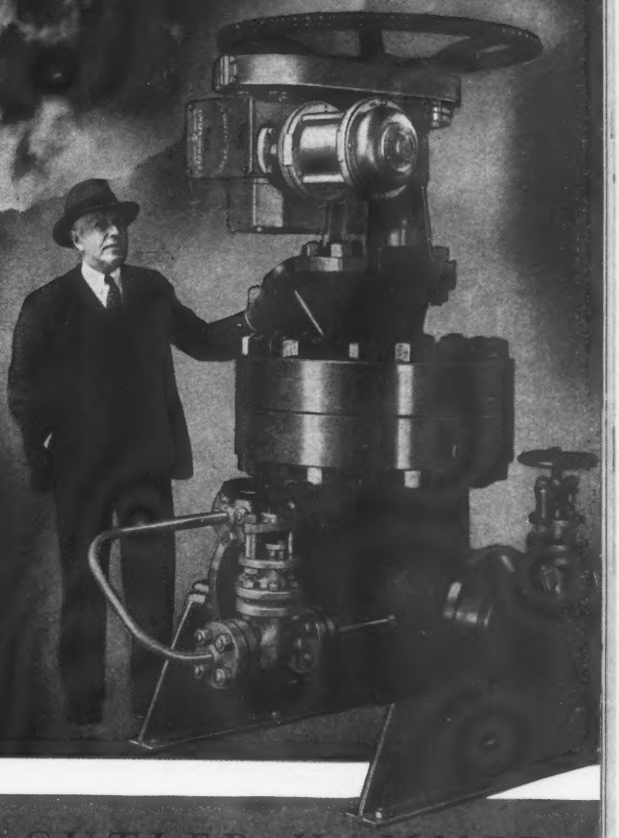
Ont., Bobcaygeon — Municipality, W. C. Moore, chn. Light & Power Comn., Town Hall, voted bonds constructing extensions to hydro-electric plant and installing one extra wheel and generator of 168 hp. $65,000.

Ont., Malton—Hydro Electric Power Comn., 620 University Ave., Toronto, soon takes bids complete equipment for hydro-station.

Que., Quebec City—Nat. Electricity Syndicate, (branch of Provincial Govt.). S. A. Bauline, chn., Parliament Bldg., plans constructing 40,000 hp. hydro-electric power development on Riviere des Quinzes. $3,500,000. Private plans.

"Engineered the Power Plant Way"

MAKES C-H VALVE UNITS TODAY'S CHOICE



ENGINEERS agree that efficiency in power generation carries us steadily toward higher temperatures. But temperature "heights" depend on man's ability to handle them.

The extraordinary care with which Cutler-Hammer valve operating units are built, their characteristic "power plant engineering" are directly in line with the pattern laid down by Power Plant Engineers. Once this comparison is made, it is easy to understand the almost universal preference for Cutler-Hammer valve operating units. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus*, 1209 St. Paul Avenue, Milwaukee, Wisconsin.

PHOTO COURTESY BUREAU OF MINES

CHECK THESE EXCLUSIVE CUTLER-HAMMER FEATURES

SPECIFIC METALLURGY. Steam temperatures of 900° and above eliminate the possibility of haphazard choice of valve materials. C-H units also employ the specific alloy and treatment best suited to the function of each part. Write for specifications.

MOTOR INSULATION. C-H valve unit motors have class B asbestos and mica, flame-proof insulation, standard for a 75°C rise.

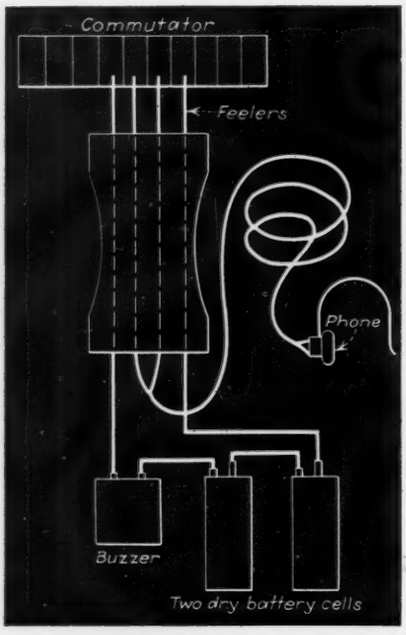
AUTOMATIC DISENGAGEMENT. To "brake" an operating unit on the valve seat would subject the valve to heavy strains. Therefore, C-H employs automatic disengagement of driving unit at exact moment of seating. Driving unit then runs free until its inertia is spent.

TIGHT SEATING OR POSITION SEATING. Some types of valves demand tight seating. Others properly should be position-seated. C-H valve control provides either method.

READY ALWAYS FOR MOTOR OR MANUAL OPERATION. For a power plant valve operating unit to fulfill its purpose, it should be immediately operable either by hand or by motor. In C-H units, neither type of operation can interfere with the other. Remote control is always available in case of emergency.

CUTLER-HAMMER
VALVE CONTROL
C-H

Practical Aids to Operation



Handy Armature Testing Set

THE DIAGRAM shows an armature-fault tester that we have used for over 25 years. It comprises a 4-point feeler, a head telephone receiver, a buzzer and two dry cells. The telephone receiver connects to the two center points of the feeler; the buzzer is connected in series with the batteries and their free terminals connected to the outside points of the feeler.

The feeler is used by applying it to the commutator and noting the sound in the phone, then moving the feeler one segment and noting the sound again. A sound in the phone higher or lower than normal indicates something wrong in the armature and calls for investigation. A sound in the phone above normal indicates a coil with a high resistance connection or one that is open circuited. A sound below normal represents a coil that has a short circuit.

An advantage of the test set is that it can be taken out of the shop onto the job. I have a set attached to my work table on which the buzzer is taped to the batteries and hangs in a canvas bag under the table out of the way. The phone, a lineman's head set, hangs on a hook. The cord for the feeler is attached to a window-shade roller and winds off on the roll like a shade. Spring contacts, to which the battery and buzzer leads connect, rest on copper ferrules on the ends of the roller to make contact with the feeler leads.

To locate a grounded coil or commutator bar, I space the battery terminals one pole apart on the commutator and tape them in place. Then, with one phone lead on the armature shaft, I touch the commutator bars with the other. The lowest sound will be obtained on the bar nearest to the ground.

Beavertown, Ore. F B CROMIEN

More Boiler Capacity In Same Dimensions

WE WERE short of boiler capacity in our plant. To install a boiler of larger dimensions would have caused considerable delay and added to the expense of the change. As an alternative, I conceived the idea of a boiler similar to the old one, but with added tube area. The old hrt boiler had 72 4-in. tubes, the new one has 128 3-in. tubes, which increased the steaming capacity 25%.

To install the new boiler we removed the top section of one side of the old setting, rolled the old boiler out and the new one into place. All the flanges on the new boiler lined exactly with the piping and the connections were made without any expense for changes. The change was made in 2½ days, 1½ of which was Saturday afternoon and Sunday, so that the plant was out of service only one working day. The smaller tubes have been highly satisfactory in our plant burning mill shavings as fuel, but they might not work as well with coal firing.

Vancouver, B. C. R M ORR

Portable Bench for Elevator Repairs

WHEN a large repair job has to be done on elevators, one of the primary problems is to go onto the job with sufficient tools. At the Bank of Manhattan Bldg we have solved this problem by building a portable tool storage and work bench (see photo). This bench is of heavy construction mounted on four ball-bearing casters. The top of the bench mounts a heavy vise. Four drawers that can be padlocked closed provide storage for tools and other equipment found necessary to efficiently do the average repair job. These include wrenches, hammers, chisels, screwdrivers, hacksaws and other tools, extension lights, tapes, a soldering kit and many other pieces of equipment.

The bench is small enough to be taken on to any elevator in the building and through any door. Now, when the mechanics go to do a major repair job, the portable work bench is taken along, giving them everything they need to do the job.

New York, N. Y. WM DEVAUGHN
Elevator Engineer

Spare Assemblies Reduce Heating Costs

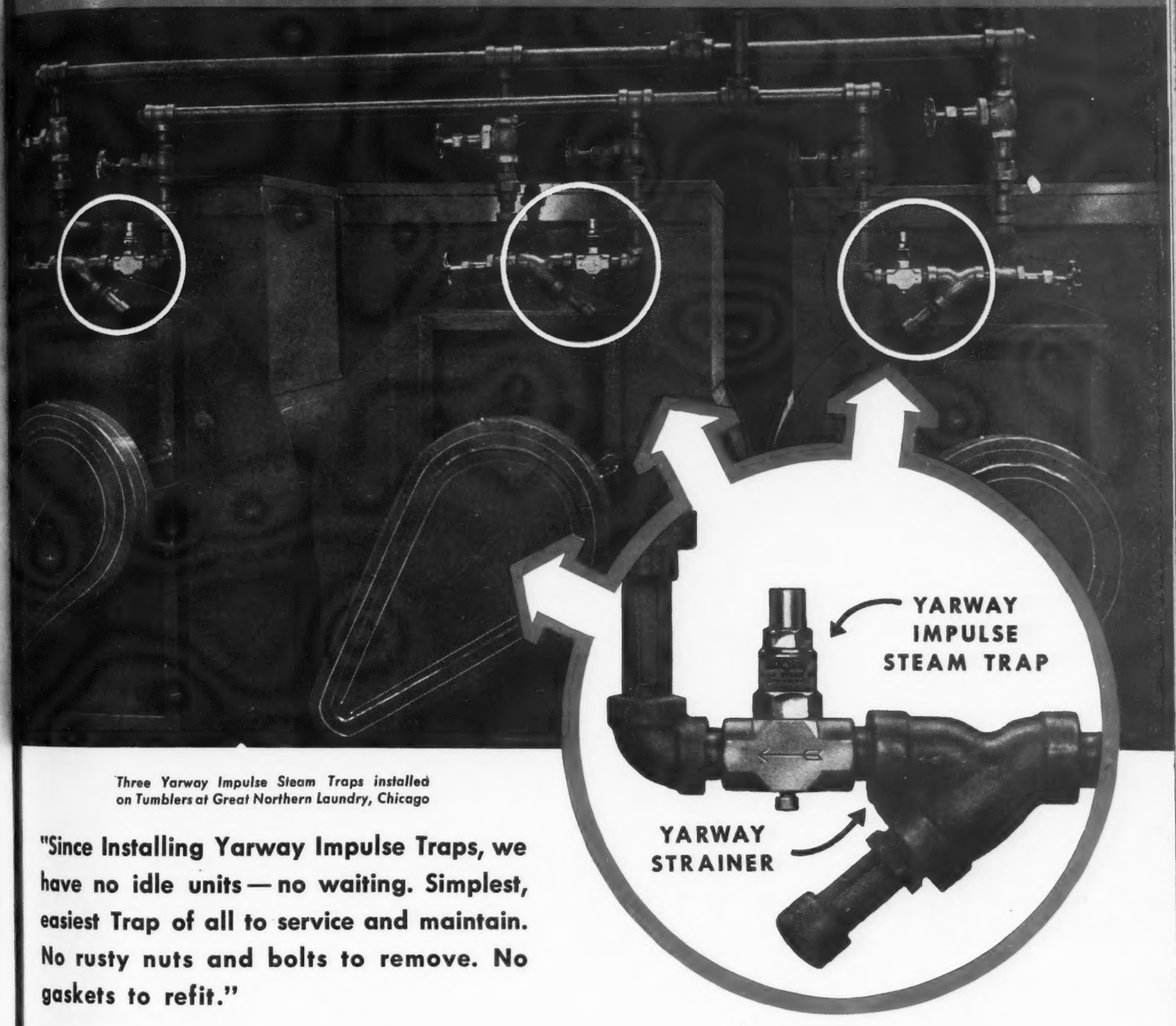
THE EXPENSE of removing scale and deposits from coils, tubes and other surfaces of heat-transfer devices is a major maintenance-cost item of many process industries. Included in this cost is the actual labor and materials required to do the cleaning, and also many hidden charges incidental to the equipment being out of service during the time ordinarily needed to do an effective job.

Unfortunately, most maintenance accounting systems ignore these outage losses altogether, and the indicated cost is misleading in that it is only a fraction of the total expense involved. While outage losses will necessarily vary in different plants, it will be usually found that any practical method of reducing the time necessary to clean heat-transfer surfaces is worthy of consideration.

Among the alternatives to tedious, time-consuming hand-chipping and -scraping are mechanical cleaners, sandblasting and chemical solutions. Where tough deposits on the exterior

"YARWAY Traps Save Time and Expense . . . Give Greater All 'Round Efficiency"

SAYS GREAT NORTHERN LAUNDRY, CHICAGO



Three Yarway Impulse Steam Traps installed on Tumblers at Great Northern Laundry, Chicago

"Since Installing Yarway Impulse Traps, we have no idle units — no waiting. Simplest, easiest Trap of all to service and maintain. No rusty nuts and bolts to remove. No gaskets to refit."

Why don't you try a Yarway Trap in your plant? Let it demonstrate its quick heating and sustained heating efficiency. Let it show you how to end servicing troubles, how to save money on installation, maintenance and fuel consumption.

And you, too, will soon standardize on this new kind of trap that works on an entirely different principle—that has won widespread preference on its superior performance on the job—when you find out that it is usually cheaper to buy new Yarways than to repair the old traps now in service.

See your industrial supply distributor. He sells them. Sells more of them than any other trap. Or write for Catalog T-1733.

YARNALL-WARING COMPANY
100 Mermaid Ave. Philadelphia

YARWAY IMPULSE STEAM TRAP

surfaces are to be removed, sandblasting is quicker and more effective than any other mechanical means. Formations on the insides of tubes, or brittle deposits on the outside that can be vibrated loose, are best removed with rotary or vibrating-type cleaners driven by air or water. Where a satisfactory chemical solvent can be found for the deposits, this method is perhaps the quickest of all, as the cleaning solution can be circulated through the encrusted spaces without dismantling the equipment.

In cases where outage costs with any cleaning method are excessive, spare heating-surface assemblies arranged so that they can be quickly substituted for dirty assemblies in the process equipment are often justified. One large chemical plant has made provisions for this by designing such surfaces as a combination of one or more similar units, all of which are interchangeable. Dirty units can be withdrawn and clean spares inserted in a few minutes. The dirty surfaces are then cleaned and made ready for use in the next piece of equipment that becomes fouled.

Richmond, Va. C R ANDERSON

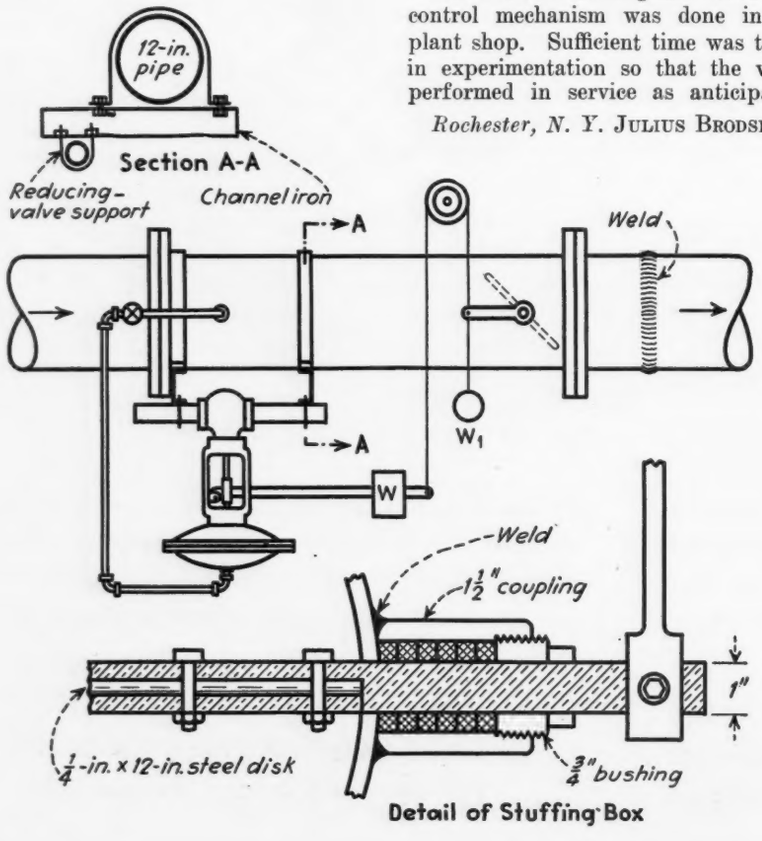
Butterfly Valves Solve Control Problem

IN AN exhaust-steam heating system, during periods of light load, there was more steam available than was required for feedwater and service hot-water requirements. It was desirable to use the surplus in the building-heating system. Attempts to regulate the amount flowing to the heating system by a 12-in. gate valve so that heater pressure would not drop below atmospheric were unsuccessful.

Operating difficulties could be corrected by the purchase and installation of an automatic valve that would function as required. Such a valve would involve a considerable investment, which was not readily available. Therefore, consideration was given to making a home-made one. Using a short flanged section of 12-in. pipe that was on hand, a butterfly valve was made, see diagram. Automatic features were supplied by a discarded diaphragm-motor-operated reducing valve that was reconditioned and connected to the butterfly valve by appropriate levers and cable and pulley arrangement. The diaphragm motor valve is supported by two short lengths of pipe attached to two pieces of channel iron clamped to the 12-in. pipe as shown in Section *A-A*. The diaphragm and lever of the diaphragm valve are so connected that if the pressure of the supply side of the butterfly valve drops to atmospheric, this valve will close. When pressure rises above a predetermined value, the diaphragm of the reducing valve starts moving up and raises the lever with weight *W*. This permits weight W_1 to take a lower position to start opening the valve.

All work in making the valve and control mechanism was done in the plant shop. Sufficient time was taken in experimentation so that the valve performed in service as anticipated.

Rochester, N. Y. JULIUS BRODSKY

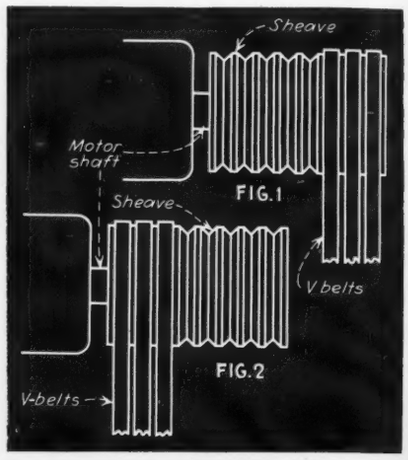


Detail of Stuffing Box

Locating V-Belt On Wide Sheave

WHEN a wide V-belt sheave is only partially used, do not place the belt at the outer end of the sheave, as in Fig. 1, but put the belt at the inner end of the sheave, Fig. 2. The former is commonly done because it is the easiest.

In Fig. 2, pressure on the bearing



will be less because the load is applied nearer to the bearing than in Fig. 1. With any belt drive, the farther the center of belt pull is from the bearing, the higher the loading on the bearing, other conditions being equal. Consequently, the greater will be the friction and loss of efficiency.

Newark, N. J. J H SQUIRES

Putting Safety Into Safety Valves

PROPER maintenance of safety valves is an essential factor in safe boiler operation. Lifting levers are provided, and the valve should be lifted from its seat for a few seconds every day the boiler operates. Do this when there is sufficient steam pressure to blow out any dust or deposits that might score the valve seat.

At least once each week, while the boiler is in service, increase pressure to popping value, keeping a check to see if the pressure exceeds that at which the valve is supposed to be set. Needless to say, the pressure gage must be accurate. When pressure rises higher than the supposed safety-valve setting, without popping the valve, immediately make adjustments and check to determine if anything else is not in proper working order. No one, except persons authorized by the chief engineer, should be allowed to touch a safety valve. Maintain a written record of adjustments or repairs, preferably in a log book. This is a law in some states.

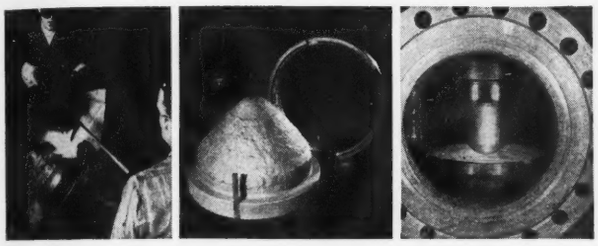
Photo News valve values

THE EDWARD VALVE & MFG. CO., INC. • EAST CHICAGO, INDIANA

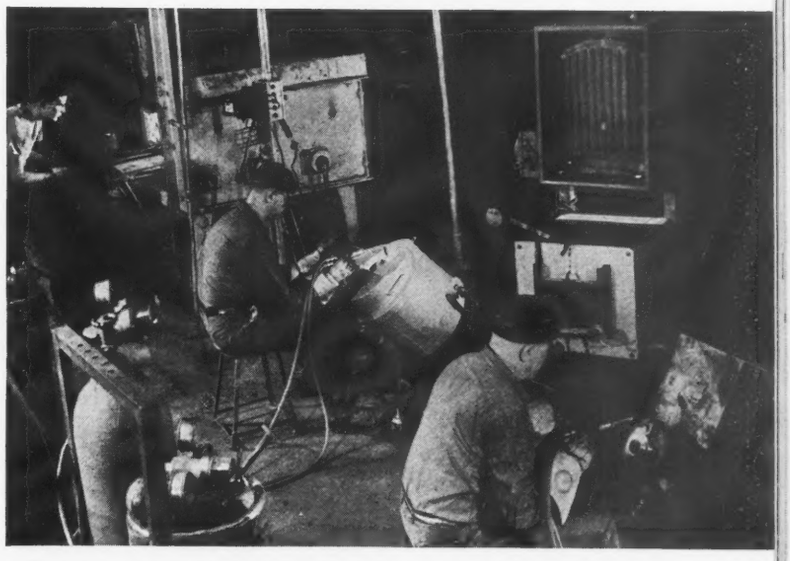
WAR ON WEAR! Use Edward Valves to

STRENGTHEN FORCES ALONG EROSION-CORROSION-ABRASION FRONTS

HOSTILITIES GO ON, directed from staff headquarters in Edward laboratories. Material control is directed — more vigorously, more intelligently, and more resultfully — to reinforce sound design and precise workmanship on basis of records of years of battle against forces tending to shorten valve life.



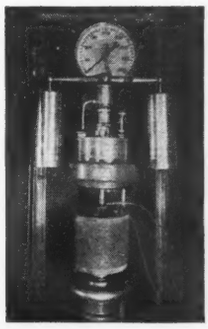
EROSION CONTROLLED by Stelliting 16 in. Edward valve shown in three pictures above. Contact surfaces and parabolic flow areas were coated with 20 pounds of Stellite before machining to form. This valve harnesses steam flows up to 350,000 lb per hr in large trans-Mississippi plant. On New York's East River front, 24 in. seat and disk similarly armored by Stelliting.



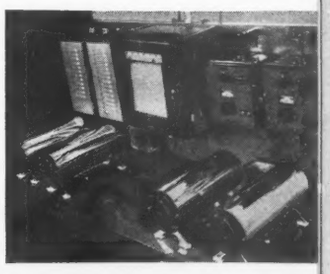
COBALT - CHROMIUM hard surfacing, Stelliting to you, is formidable element in war against attrition. Even when hot it presents impregnable front against forces of wear. Sometimes it is particularly valuable to combat corrosion. Shown above is mechanized equipment, developed by Edward, for quality control at low cost. Skilled technicians supervise heat processing and torch-application of surfacing, essential for best results.

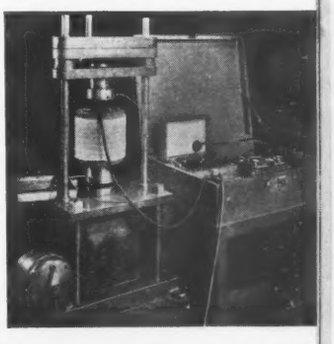
CORROSION ATTACK differs according to nature of reagents, cyclic or aperiodic stress, exposure to oxygen or tainted atmospheres, and many other details which form basis of endless incursions into unknown territory, through Edward chemical laboratory activities. Cut shows array of beakers holding standard samples under exposure to still, cold, corrosive solutions of varying strength.

VALIANT WARRIOR against allied wear forces is Edward Fig. 2688, forged steel stop valve designed and built for leadership of shock forces of defense. See Edward Catalog No. 11 or 101 for details of this and other Edward forged and cast steel and high strength iron valves. They've all got stamina.



HEAT WORRIES defensive forces against wear. Edward contributes new specialized tests. Battery of furnaces (upper right) helps, by high temperature heating for thousands of hours, to detect "aging," temper brittleness, grain changes, loss of hardness, and other manifestations which signify reduced resistance to wear. Abrasion tests (lower right) are made at high temperatures on material specimens and actual valve parts. Specimens heated long periods are tested (left) in electric furnace mounted on Brinell machine to find hardness under heat. Time effect seriously reduces hot hardness of some materials which show favorable qualities at room warmth.





EDWARD VALVES

Stop · Check · Blow-off · Non-return · Feed Line · Relief · Bleeder Line · etc.

Blowback of safety valves is usually controlled by adjustment of a notched ring. In many cases, this adjustment may be made by a screwdriver through a plug-hole in the valve body. Blowback is the number of pounds drop in pressure from that at which the valve pops to closing pressure. If this drop is too great, a loss of steam and plant efficiency results. Too small a blowback causes the safety valve to pop too frequently, sometimes even to the point of chattering before combustion can be checked. The ASME Power Boiler Code P-281 now reads:

"a. Safety valves shall operate without chattering and shall be set and adjusted as follows: To close after blowing down, not more than 4% of the set pressure, but not less than 2 lb in any case. For spring-loaded pop safety valves for pressures between 100 and 300 psi both inclusive, the blowdown shall not be less than 2% of the set pressure. To insure the guaranteed capacity and satisfactory operation, the blowdown as marked on the valve shall not be reduced."

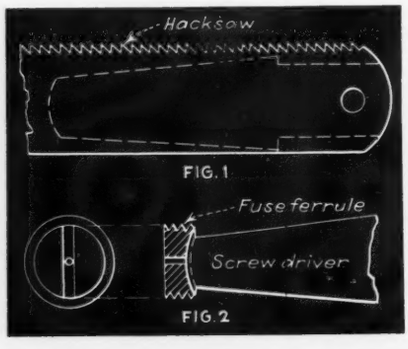
"b. The blowdown adjustment shall be made and sealed by the manufacturer." (Note: for new installations).

Checking and maintaining the proper blowback (or blowdown) should be part of every power-plant maintenance program. It might seem unnecessary to mention plant cleanliness, but as safety valves are located on boiler tops, and boiler tops appear to be too often neglected, this paragraph is a reminder. Safety valves are carefully machined and constructed, and no machinery will operate properly for long if buried under soot and coal dust. Keep boiler tops clean by properly sealing the setting and coal passages.

Probably the most dangerous mistake with safety valves can occur after a hydrostatic test on a boiler. Usually this water test is conducted at a higher pressure than the safety-valve setting. In order to prevent the safety valve from spraying water over the boiler, and to obtain the necessary test pressure, the safety valve is removed and the connection blanked off, or, a clamp is placed over the safety-valve spindle to keep it closed. If the safety valve is not restored to normal before the boiler is put into service, an explosion might result. The person in direct charge should always remove the blanked connection or the clamp from the safety valve immediately after the test is completed.

The responsible engineer in one large plant has had a notice painted in 4-in. red letters on a sign, saying: "SAFETY VALVE GAGGED." In slightly smaller letters directly below, the sign warns: "This sign must not be touched excepted by the engineer who must not remove it until he has seen gags removed." This sign is placed across the boiler front when making hydrostatic tests, and removed as the notice indicates. As some municipalities require an annual hydrostatic test on steam boilers, tagging of a boiler that has inoperative safety valves is highly recommended.

Canton, Mass. H M SPRING



Screw Driver for Cartridge Fuses

BECAUSE the screw slot in the end plugs of renewable fuses is deeper in the middle than at the edges, it is sometimes difficult to turn them with an ordinary screw driver without bruising or distorting the slot. If a wide screw driver is available, it may be ground round on the end for this job, or a stubby round nosed one may be made from a piece of a discarded power hack-saw blade.

The piece of blade is ground as shown by the dotted lines in Fig. 1, leaving the hole in the end for the rivet through the ferrule on the handle. The handle may be made from a piece of a broom stick, or what have you, and a piece of ½-in. pipe sawn off for the ferrule.

Coffeyville, Kan. EARL PAGETT

High-Temperature Furnace Connections

WHERE draft gages or gas-analysis instruments must be connected to places in boiler furnaces exposed to extremely high temperatures, ordinary piping materials inserted through the refractory walls are unsatisfactory. The metal either fuses, offering a lodging place for masses of slag, or it burns back into the wall, allowing gas samples to be diluted with air. These troubles can be avoided by using pieces from a broken high-temperature soot blower element.

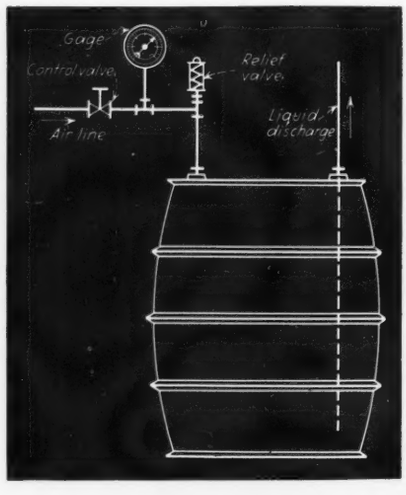
These elements are made of high-temperature-resisting alloys and can be readily adapted for furnace connections by plugging the nozzle openings and brazing a tee for the instrument connection and clean-out plug on the end of the section extending outside of the furnace. The soot-blower-element pieces can also be used for gas-analysis connections in the first pass of the boiler where the sampling tube must extend into the gas passage for some distance. If the sampling tube enters the pass horizontally, it must be supported with hangers.

Roanoke, Va. S H COLEMAN

Safety First When Emptying Drums

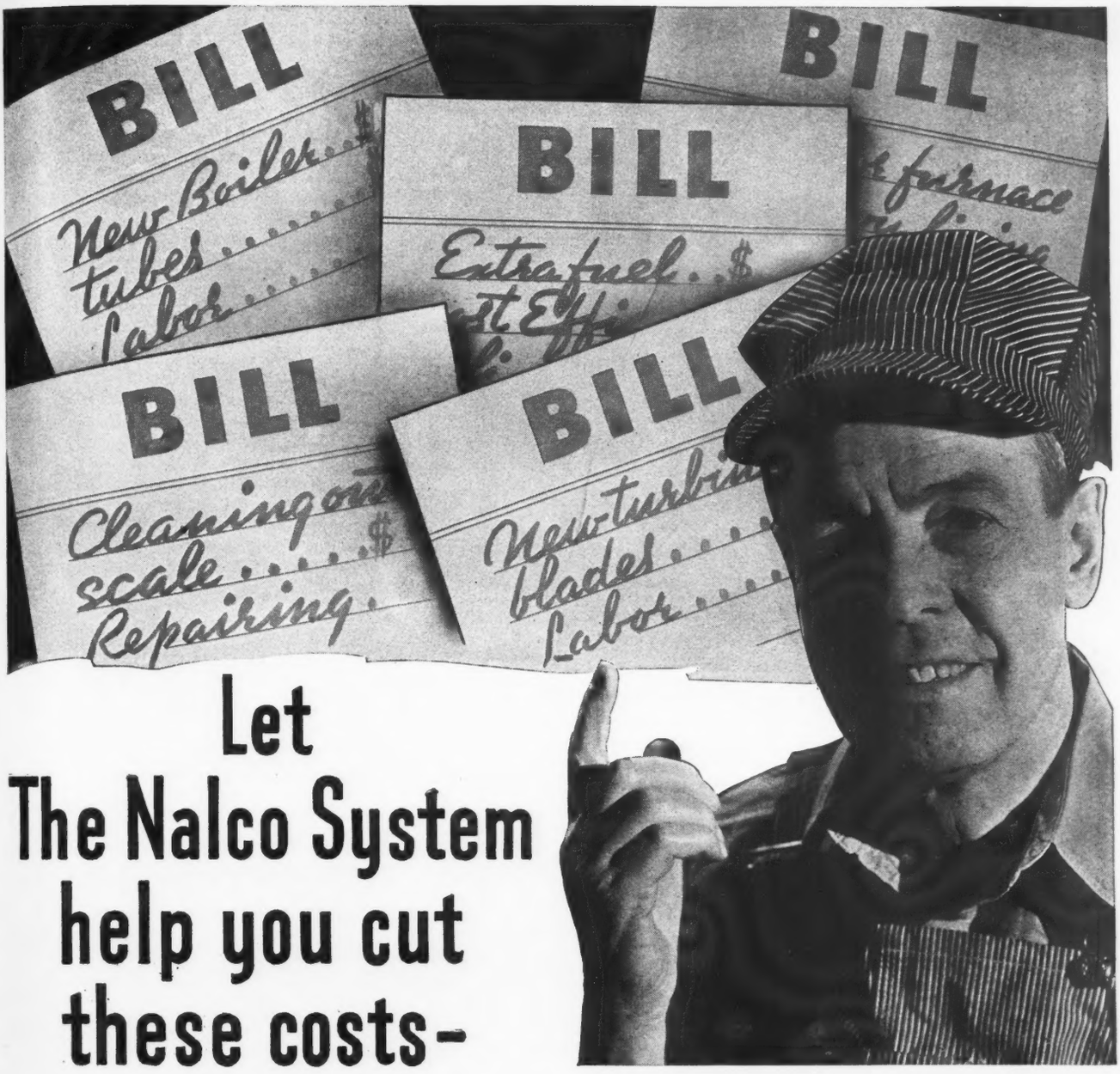
AIR PRESSURE is utilized in many plants to transfer liquids from steel drums on one level into storage tanks or other receivers at a higher level. While this method of handling eliminates lifting heavy drums, care must be used to avoid exceeding the bursting strength of the drum and possibly injuring persons or equipment in the vicinity. This has happened in the past and is known to have caused at least one fatality.

How much pressure will such a drum stand? This depends on its design and condition at the time the pressure is applied. Rough handling



may have injured the seams or corrosion may have impaired the strength of the metal. With these limitations, 10 lb would seem to be the top limit. If air pressure is used, manual regulation of the air-supply valve or accuracy of a gage on the drum should never be depended upon entirely. Always place a safety valve in the air line between the control valve and the drum, as in the figure. Adjust this valve for a pressure slightly above the pressure required to lift the liquid.

Roanoke, Va. S H COLEMAN



Let The Nalco System help you cut these costs-

NOW is a good time to check up on your 1938 costs. Take a look at the bills for boiler tube cleaning . . . new tubes and plates . . . furnace repairs . . . and bills for fuel. Follow this up by calling in a Nalco field man. He'll be glad to give you an idea of how you compare with other plants.

This is an easy way to check your costs and it is dependable. Plants served by the Nalco System consistently show savings on all items affected by feedwater.

Adoption of the Nalco System requires no additional capital investment. Total cost is frequently less than your present expenditures for chemicals alone. Write for complete information. NATIONAL ALUMINATE CORPORATION, 6222 W. 66th Place, Chicago, Illinois.

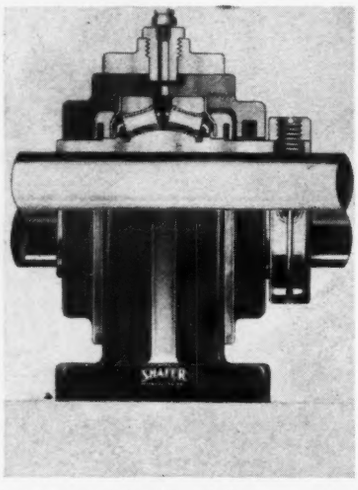
ANY WATER **NALCO SYSTEM** ANY PRESSURE

Inquiries other than domestic, *except those from U. S. Possessions, Canada and Mexico,* should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, Eng. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.

What's New in Plant Equipment

Pillow Blocks

TWO LINES of pillow blocks, first of which (see photo) has welded steel housing and seal to protect against dirt. An outer felt seal floats in cover groove, and is in uniform contact with inner bearing race. Inner seal plates are mounted between covers and bearing, forming bearing lubricant chamber. Washers are pressed on inner race, and together with inner seal plates, form modified labyrinth seal. Large recesses formed by inner seal plates and covers



prevent contamination of lubricant within bearing chamber. For shaft sizes $1\frac{7}{16}$ to $3\frac{5}{16}$ in. Second line of pillow blocks also has welded-steel housing double-row roller bearings, extended inner race and two drive collars. Automatic compensation is provided for misalignment or shaft deflection up to $1\frac{1}{2}$ deg each side of center. Both fixed and expansion blocks have piston-ring seals and Alemite lubrication fittings; available in sizes from $1\frac{7}{16}$ to $8\frac{1}{2}$-in. bore.

Shafer Bearing Corp, 35 E Wacker Drive, Chicago, Ill.

Welding Compound

"SPATTER FILM" compound is said to reduce cleaning time after welding by 20 to 60% by reducing tendency of spatter to adhere tightly, thus facilitating its removal. Is soluble in water, non-inflammable, contains no free alkali, and can be applied by ordinary paint brush. Only enough of film need be applied to cover work adjacent to seam or joint. A gallon will cover approximately 50,000 sq in. of surface.

Lincoln Electric Co, Cleveland, Ohio.

Oil Reclaimer

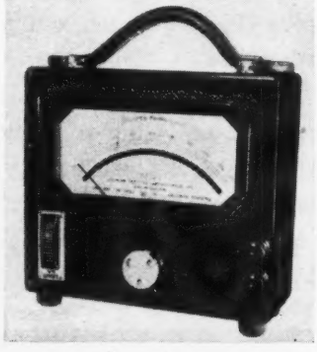
"HILCO" oil-reclaiming units are manufactured in three models for direct connection to lubricating systems of stationary and marine diesels. These units may also be used as batch reclaimers where

operator prefers to drain engine-lubricating system and deliver oil to a dirty-oil receiving tank, from which the Hilco draws its supply. Filtering agent is a Fuller's earth, which is said to remove all carbon, sludge, resins, gums, acidity and restore color by adsorption. Unit is all-electric and automatic, requiring attention only once every 24 hours to renew filtering material. Made in various capacities for either continuous bypass purification or batch operation.

The Hilliard Corp, 4 West 4th St, Elmira, N. Y.

Portable Pyrometer

ADDITION to line of pyrometers is shockproof portable instrument with spring-suspended movement within case to minimize shocks and jars. Other features of this instrument include new type pointer



lock to damp movement of instrument when carried, heavy metal case, and shatter-proof glass. Scale length is 5 in.

Illinois Testing Labs, Inc, 420 N LaSalle St, Chicago, Ill.

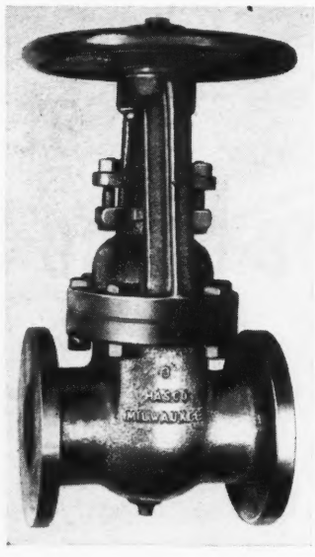
Marking Crayons

"HOT-RITE" crayons for marking on hot steel and other metals subjected to high temperatures will not melt or run off; yellow and white crayons will withstand as high as 1500 F. May be applied to cold steel and later subjected to heat without becoming obliterated. Made in five colors.

Eberhard Faber Pencil Co, 37 Greenpoint Ave, Brooklyn, N. Y.

Severe-Service Valve

GATE valve for severe process conditions is made of $1\frac{1}{2}$% nickel steel, with Meehanite disks faced with Monel rings and removable seat rings, and $3\frac{1}{2}$% nickel-steel forged stem. Machined concave and convex contacting surfaces on inner sides of disks are large enough in diameter so that they are directly behind seating surfaces. This eliminates distortion of disks when valve is closed. Large guide ears on disks help prevent breakage at this point. Disks are held in place



by steel collar welded on stem to eliminate possibility of disks dropping down in valve when in operation. Rising stem is actuated by large bronze nut in handwheel.

Hasco Valve & Machine Co, 1819 W St Paul Ave, Milwaukee, Wis.

Pump Bypass Control

SMOOT automatic pump bypass control has been developed to prevent overheating of large high-pressure centrifugal pumps when operating under low-load conditions. When flow through a pump reaches a measured predetermined low flow, this pump control automatically opens a bypass valve, permitting a measured amount of water to flow from pump discharge to some convenient point in the feedwater circuit, from which it will flow back to feed-pump suction. This assures a continous flow through the pump of sufficient volume to prevent overheating. The pump bypass remains

Then came BUROMIN!

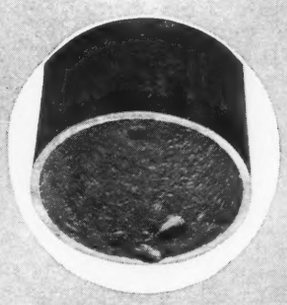
BUROMIN PREVENTS THESE EVILS

SCALE LIKE THIS

Even when no thicker than 1/100 of an inch, forming at the hottest part of a boiler tube, may lead to costly destruction.

PITTING

Here's a cross section of a boiler tube that was destroyed, in only a few months, by pitting. Correctly conditioned boiler water would have saved this tube.



EMBRITTLEMENT

Improperly conditioned boiler water allows "caustic embrittlement" to start. Tough steel often fails like brittle glass.

CARRY-OVER

Of course boiler water should stay in the boiler. When it doesn't, in the case of incorrectly conditioned water, and carries over with the steam, super heaters frequently plug up like this.

BUROMIN

THE BUROMIN COMPANY

300 ROSS STREET • PITTSBURGH, PA.

Though a story old to thousands of firms in almost every conceivable industry, it may still be new to you. If so, it is an invitation to find out about one of the greatest improvements in power plant history.

SINCE steam power first became a force in industry, incorrectly treated boiler water has exacted a fearful price. Costly, repeated shutdowns and replacements due to corrosion, scale, pitting, carry-over and embrittlement, the failure of "mysterious" chemical remedies, gave power plant operators endless worry.

Then came BUROMIN and The Hall Laboratories' System. Guesswork gave way to science. Out of the laboratory, after years of painstaking, costly research, came positive proof that boiler water at any place, of whatever character, could be definitely and correctly conditioned —that those evils inherent in water could be permanently, surely, economically remedied.

As with any revolutionary development there was skepticism. But not for long. Word of BUROMIN'S performance rapidly passed from one plant to another. Today, leading boiler room operators on land and sea, at home and abroad, could not be induced to operate without BUROMIN and The Hall Laboratories' system. Its development represents an industrial romance.

Then why continue to expose your expensive equipment to chemicals which by some "mysterious" means are supposed to end your troubles? There is no mystery about BUROMIN, a pure substance which is glasslike, quickly soluble, and the application of which is scientifically directed.

Without obligation, our engineering personnel will lay the truth before you. They will show you how you can correctly condition your boiler water and permanently avoid costly failures. Write, wire or phone.

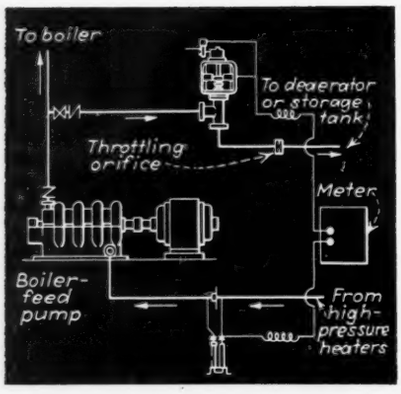
This request may save you many dollars:

THE BUROMIN COMPANY
300 Ross St., Pittsburgh, Pa.
Gentlemen:
Please send me, without obligation, your new booklet "Buromin—for clean boilers, continuous service, enduring economies, lasting satisfaction."

Name.....

Position.....Company.....

Address.....

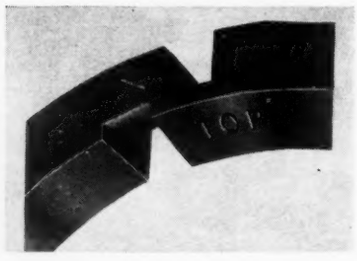


open until flow through pump increases to a second predetermined rate of flow, at which point bypass closes automatically. A 2-pen recorder records on a single chart total flow of water through pump, amount of water bypassed, time bypass opens, duration of opening and the time bypass closes.

Republic Flow Meters Co, 2240 Diversey Parkway, Chicago, Ill.

Piston Rings

"SEAL CUT" Pedrick piston rings have specially designed lap fit to prevent leakage past the ring. These rings are heat shaped, which is said to insure equal distribution of radial pressure throughout circumference of ring and to pro-

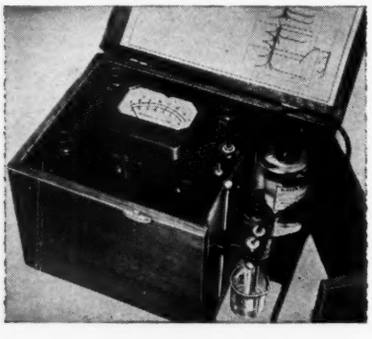


vide a black iron-oxide protective coating. In addition, manufacturer can provide special "Silcoat" finish, claimed to give quicker seating and elimination of cylinder-wall scuffing during wearing-in period. Made in all sizes for air compressors, pumps, gas engines and oil engines.

Wilkening Mfg Co, Philadelphia, Pa.

pH Meter

BEEKMAN industrial pH meter uses glass electrodes immersed in test solution. Minute electric potential is generated



that varies with the pH. This potential is strengthened by an electronic amplifier to operate a calibrated meter, reading in pH. Both electrode system and lead wires are completely shielded, preventing electrostatic interference. If the electrodes are placed in a flowing solution or in a tank where pH is subject to fluctuation, and switch is kept on, the meter will continuously and automatically indicate pH of the solution. A dual-scale meter controlled by a switch covers the acid range 0 to 7 over the full scale on one adjustment and the alkaline range of 7 to 14 on the other.

National Technical Laboratories, 3335 E Colorado Blvd, Pasadena, Cal.

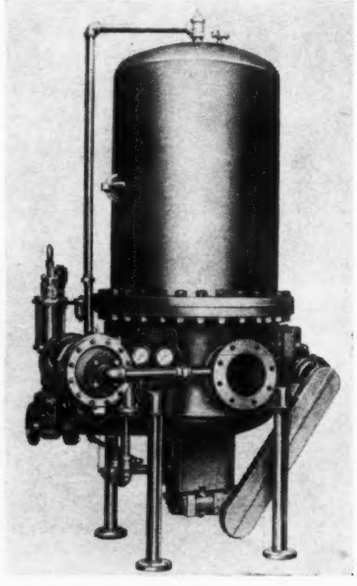
Gage Glass

"PYREX" broad red-line gage glass differs from previous types in that red stripe is transparent, is proportioned to diameter of tube, and is fused permanently to wall of gage glass. Transparent red line makes it possible for the first time, it is said, for light to pass through red stripe and water column from the rear. A small slotted illuminator directly back of gage glass produces brilliant visibility under all conditions. Made in lengths to 24 in. and diameters ½ to 1 in. inclusive.

Corning Glass Works, Corning, N. Y.

Filter

TYPE FKR "Flo-Klean" filter for removal of fine dirt and sand from river water is a self-cleaning wire-wound filter of low pressure drop and has no loss of backwash water. Cleaning is continuously accomplished by slowly rotating a cartridge past a stationary backwash nozzle. Thus each portion of filter element en-

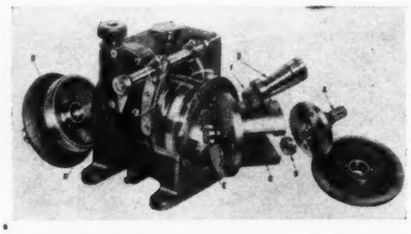


counters momentary reversal of flow which disloges accumulated solids. Backwash supplied by booster pump is obtained from a portion of cleaned liquid which has already passed through filter, and is returned to system. Hydraulically operated automatic dumping valve opens at intervals, allowing sludge accumulated in bottom of sump to blow off. Floating sludge is simultaneously removed through a pipe connecting top sump to blowoff valve. Motor drive, backwash pump, blowoff valve and all auxiliary equipment are mounted on filter base, so that upper sump can be removed quickly for inspection of cartridge.

Cuno Engineering Corp, 284 S Vine St, Meriden, Conn.

Variable-Speed Transmission

MAKES use of metallic rolling contact to transmit power at infinitely varying speeds, output speed varying from any desired maximum down to zero speed and reverse. A carrier *C* supports two planet rollers *D* and is connected to input shaft *A* through cam *B*. Cam not only drives the carrier but at the same time applies an outward pressure to rollers in proportion to torque. Planet



rollers are tapered and also inclined to the central axis at an angle equal to ½ their taper, thus bring their outer edges parallel to the central axis. Each roller carries a planet gear *F*, which meshes with ring gear *G* fastened to driven shaft. Pressure applied by cam to tapered rollers brings them in driving contact with a cylindrical ring *E*, which is movable lengthwise of the transmission to change speed from approximately ½ of input speed down through zero and reverse. Higher or lower maximum speeds are obtained, where desired, by supplementary gearing built into transmission output end.

Graham Transmissions, Inc, 2711 N 13th St, Milwaukee, Wis.

Boiler-Water Treatment

RECENTLY FORMED American corporation will market "K.A.T.", a colloidal boiler compound originally developed for prewar Russian Navy and more recently used in France and other European companies. It is claimed that K.A.T. will prevent scale formation and cause disintegration of existing scale coatings.

American K.A.T. Corp, 122 E 42nd St, New York, N. Y.

Diesel-Driven Compressor

RIGHT-ANGLE, 2-cycle, solid-injection, diesel-driven compressor is built in 2-, 3-, 4-, 5- and 6-cyl sizes (150-, 225-, 300-, 375- and 450- hp) Each diesel power cyl-

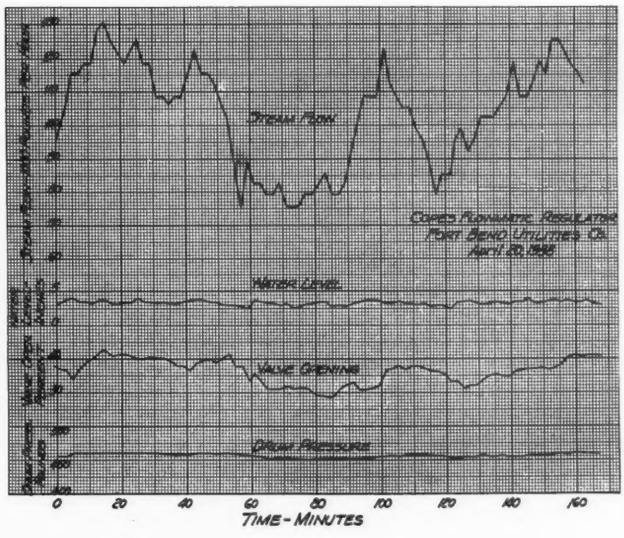
LOAD LEVEL

Fluctuating—within limits of 75,000—150,000 pounds per hour

Practically constant—extreme range of plus or minus one inch

At Fort Bend Utilities Company

The all-outdoor Riley Steam Generator carries a combined utility and sugar plant load. The steam demand fluctuates rapidly and over a wide range. The COPES Flowmatic Regulator was installed and adjusted without need of factory service. There is an extreme water level variation of plus or minus one inch.



Write for this Interesting Paper

We have just published an 8 page paper about the Fort Bend plant. It describes the major equipment, analyzes the steam demands and discusses results obtained with the new COPES Flowmatic Regulator. It is illustrated with photographs, charts and diagrams. Write today for a copy of this interesting paper.

Fort Bend proves the value of the Flowmatic

Easy installation, simple adjustment, trouble-free operation with only routine attention, close boiler water level control on the most rapidly swinging loads. These are the reasons why the new Flowmatic made good at Fort Bend—why it will make good on your fast-steaming generators.

NORTHERN EQUIPMENT CO., 911 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves
Liquid Level Controls, Reducing Valves and Desuperheaters

BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY, AUSTRIA AND ITALY . . . . REPRESENTATIVES EVERYWHERE

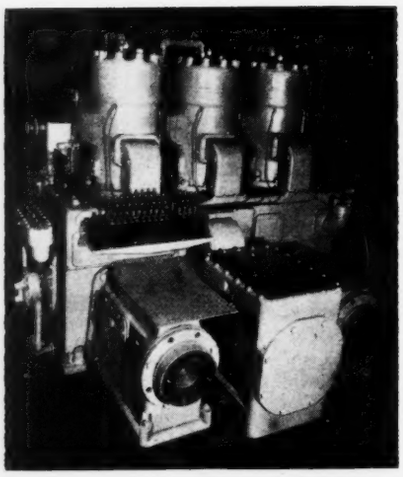
Get closer boiler water level control with the new

COPES

FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

FLOWMATIC

★ REGULATOR



inder has 13-in. bore, 14-in. stroke and normal rated speed of 300 rpm. All power cylinders are vertical and at 90-deg angle to compressor cylinders. Illustrated 3-cyl unit can be equipped with two double-acting compressor cylinders, and applied to industrial and pipeline service by removing the two compressor cylinder beds and covering lower crankcase openings.

Clark Bros Co, Olean, N. Y.

Variable-Speed Indicator

"SPEEDIAL" indicator, for Reeves variable-speed-control equipment, consists of cast hollow handwheel, metal cup containing an assembly of pinion and gear

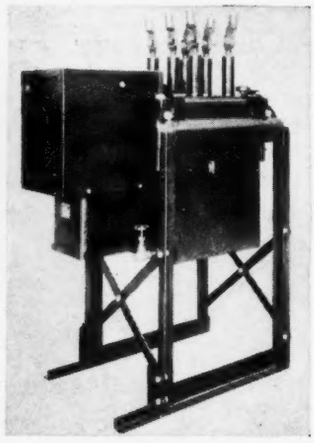
and brass counterbalance fitting into recessed handwheel, scale with pointer, and transparent cellulose lid. Complete unit is installed or removed as quickly as standard handwheel.

Reeves Pulley Co, Columbus, Ind.

Circuit Breaker

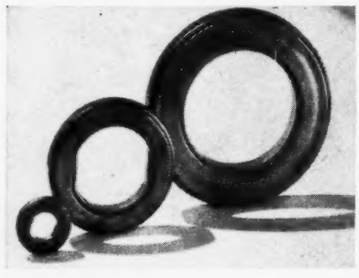
100,000-KVA interrupting rating indoor oil circuit breaker, Type FK-46, incorporates single-port cross-blast principle with heavy-duty butt-type arcing contacts and silver-to-silver main current-carrying contacts. May be operated either manually or electrically and interrupts circuit within 8 cycles (0.133 sec). Contacts are inclosed in a chamber formed by vertical and horizontal baffles. When contacts part, arc converts some oil into gas, setting up pressure in chamber. A blast of cool oil having high insulating value is forced between arcing contacts and out through three ports in vertical baffle. Because cool oil keeps arc from restriking at an early current zero, circuit is quickly interrupted.

General Electric Co, Schenectady, N. Y.



Valve Disk

ALL-PURPOSE laminated valve disk is built up of alternating layers of asbestos and metal encased in a 2-piece shell of copper, Monel or other alloy metal. Shell protects laminated parts of disk and



affords flat seating surface. Made for globe valves that require renewable disks in sizes ¼ to 12 in., with round or oblong holes.

Goetze Gasket & Packing Co, Inc, New Brunswick, N. J.

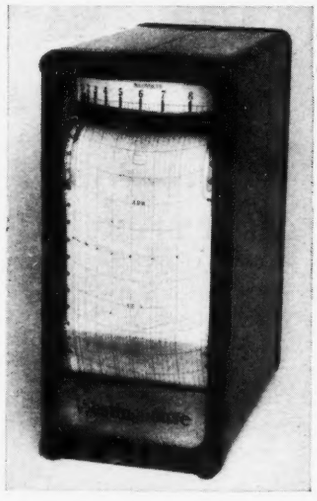
Welding Electrode for High-Tensile Steel

"FLEETWELD No. 9 HT" developed for welding high-tensile steels of 70,000 to 80,000 lb per sq in. Physical properties of weld deposits, stress relieved at 1200 F, are approximately: tensile strength, 70,000 to 76,000 lb per sq in.; yield point, 58,000 to 63,000 lb per sq in.; % elongation in 2 in., 27 to 32. Other features said to include low spatter loss, high deposition rate, easily removed slag formation, weld deposits having minimum porosity. Two sizes, $\frac{5}{32}$ and $\frac{1}{4}$ in., 18-in. lengths.

Lincoln Electric Co, Cleveland, Ohio.

Recording Instruments

G-40 RECORDING instrument has a broad line of movements to meet all conventional requirements in central-station and industrial fields. Dc voltmeter, ameter, millivoltmeter and milliammeter elements operate on permanent-magnet moving-coil principle. Single-phase wattmeter, voltmeter and ammeter elements are iron-clad, iron-core, single-element dynamometers. Movements have high-torque weight ratios, nominal volt-ampere burdens and good frequency performance. In polyphase wattmeter and varmeter elements, double-element dyna-



mometer principle is used. Synchronous and spring-driven clocks are interchangeable. Illustration shows GY-40 switchboard recording ac kilovoltmeter.

Westinghouse Electric & Mfg Co, E Pittsburgh, Pa.

Spray Gun

"THOR" Model 7E-1 is an improved spray gun for heavy materials. It is designed so that heavy materials such as asphalt paints, sound-deadener materials containing sand and other abrasives, will

flow out easily through rounded contours from inlet to nozzle. Has variety of nozzle set-ups, and ¾-in. material inlet opening.

Binks Mfg Co, 3114–40 Carroll Ave, Chicago, Ill.

AC Generators

ADDITION to line of ac generators gives manufacturer size range of 1½ to 300 kva for direct connection to gas, diesel or gasoline engines. Either direct-connected exciters or external dc excitation. Where generators are furnished with direct-con-

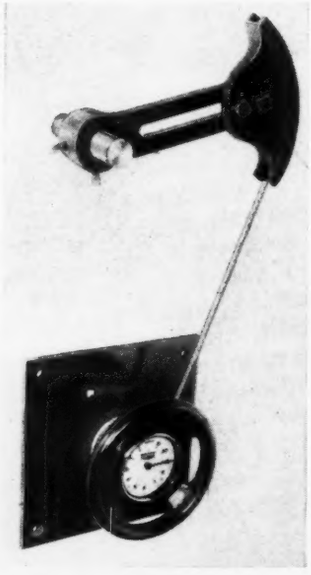
CURES VALVE GROANING
WITH 40% LESS OIL!
• GROANING VALVES on this three story, triple expansion, vertical water pump sounded like the trumpeting of a herd of bull elephants. When the Standard Lubrication Engineer was called in, he found ample reason for their bellowing complaint. Lubrication of both valve and cylinder was exceedingly poor. Valve rods were vibrating excessively. The plant engineer fully expected that a major overhaul would be necessary to put the machine in shape.
Without any mechanical changes, however, StanoCyl D was put into the lubricators. Within two hours the groaning and vibration had stopped. During the next ten days the cylinder oil feed was gradually reduced until finally 40% less oil was being used. Even on this reduced consumption there was adequate lubrication and no return of the trouble.
40% is just the average saving that Standard Lubrication Engineers have been able to make with StanoCyl. 75% is not unusual. Let one of these Engineers put the correct grade of StanoCyl in your engine and find out what your saving will be. You can reach him at your local Standard Oil (Indiana) office or by writing 910 S. Michigan Ave., Chicago, Ill. Naturally, his service costs you nothing.
Copr. 1938, Standard Oil Co.
STANOCYL
STEAM CYLINDER OIL
STANDARD OIL COMPANY (INDIANA)
LUBRICATION ENGINEERING
THE RIGHT LUBRICANT • PROPERLY APPLIED TO REDUCE COSTS

nected exciters, a special compounding, automatic voltage adjuster is available that will maintain voltage within plus or minus 5 per cent for average load conditions.

Columbia Elect Mfg Co, 4519 Hamilton Ave, Cleveland, Ohio.

Damper Controller

INDICATING damper controller is mounted on either front or side of boiler. Controller operates damper by means of an adjustable eccentric quadrant and lever arm connected to controller by cable. In combination with Tejax dial-indicator



control valve, proportionate fuel-flow and air-flow settings can be obtained. Valve is mounted in the line as near burner as possible, and has straight-line flow characteristic in relation to handwheel turns indicated by dial.

Tefft-Jackson, Inc, Providence, R. I.

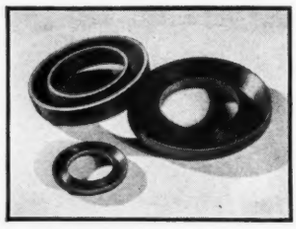
Welding Electrode

SMOOTHARC "Har-Ten" electrode designed for welding Man-Ten, Cor-Ten, High-Steel, Republic Double Strength, Yoloy, etc. Manufactures states that tests show weld made with this electrode and heat-treated for one hour at 950 F increases yield point from 68,500 to 92,500 lb, ultimate tensile strength from 83,000 to 102,250 lb, while percentage of elongation in 2 in. decreases from 15.5 to 14.8 under the heat treatment. Made in two types: *A* for flat, vertical and overhead work; *B* for flat work only. Both are available in sizes $\frac{1}{8}$ to $\frac{1}{4}$ in. in diameter in 14-in. lengths.

Harnischfeger Corp, 440 W National Ave, Milwaukee, Wis.

Leather Packings

GARLOCK "Bitan" packings made by special tanning process said to give superior tensile strength and resistance to temperature, acids and alkalies. Manufactured as molded cups, U or V packings, flange or hat packings, washers, gaskets or disks. Made in all commercially prac-



ticable sizes and for every service condition for which leather packings are suitable.

The Garlock Packing Co, Palmyra, N. Y.

Hand Tachometer *(bottom left)*

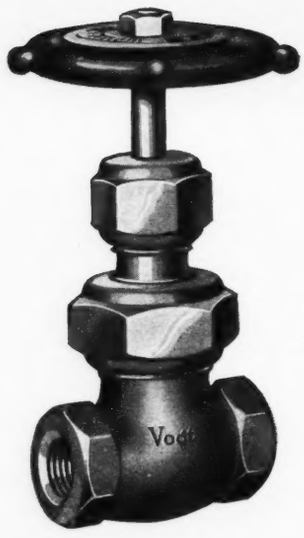
O-Z hand tachometer has range of 40 to 50,000 rpm and 12 to 15,000 fpm, $2\frac{3}{4}$-in. dial. Indicating mechanism is in black enameled housing with fixed-reading device, controlled by pushbutton in front. Three selective range steps of 40-500, 400-5000 and 4000-50,000 rpm; and with cutmeter wheel (part of outfit): 12-150, 120-1500 and 1200-15,000 fpm. Weight without carrying case, 1 lb; with Bakelite carrying case and accessories, $1\frac{1}{2}$ lb.

O Zernickow Co, 15 Park Row, New York, N. Y.

Welded Boiler *(bottom right)*

DEVELOPED for oil fields, this Class I, 1300-sq ft, welded locomotive type boiler is for 300 lb working pressure. Design has been approved by ASME and boiler has been constructed under supervision of Hartford Steam Boiler Inspection & Insurance Co. Welded seams are used in barrel, dome, firebox and tube sheet. This does away with overlapping plates and straps and reduces weight of boiler by about 10%.

Farrar & Trefts, Inc, Buffalo, N. Y.



Forged-Steel Valves

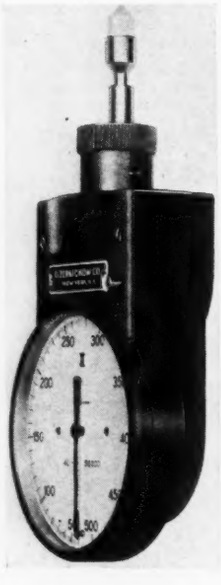
LINE of drop-forged, union-bonnet valves is made in $\frac{1}{4}$-, $\frac{3}{8}$- and $\frac{1}{2}$-in. sizes. Hexagon body ends, ground joint between body and bonnet. Recommended for 900 lb working pressure at 750 F or 1500 lb non-shock cold-working pressure.

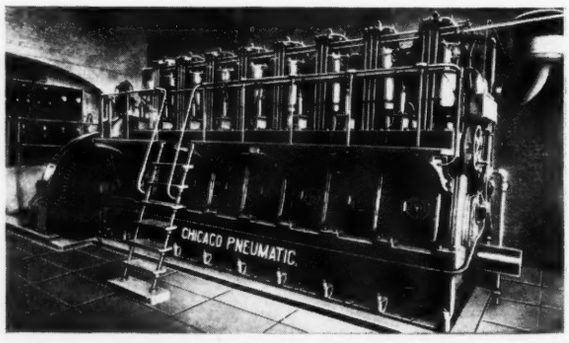
Henry Vogt Machine Co, 10th and Ormsby Sts, Louisville, Ky.

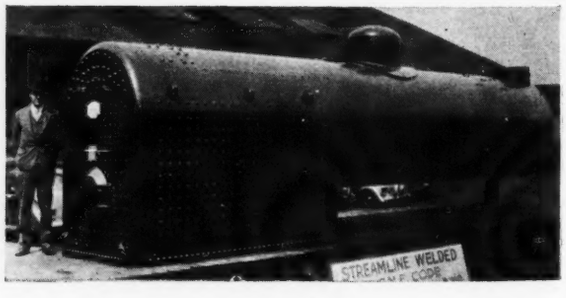
Heavy-Duty Diesel *(below)*

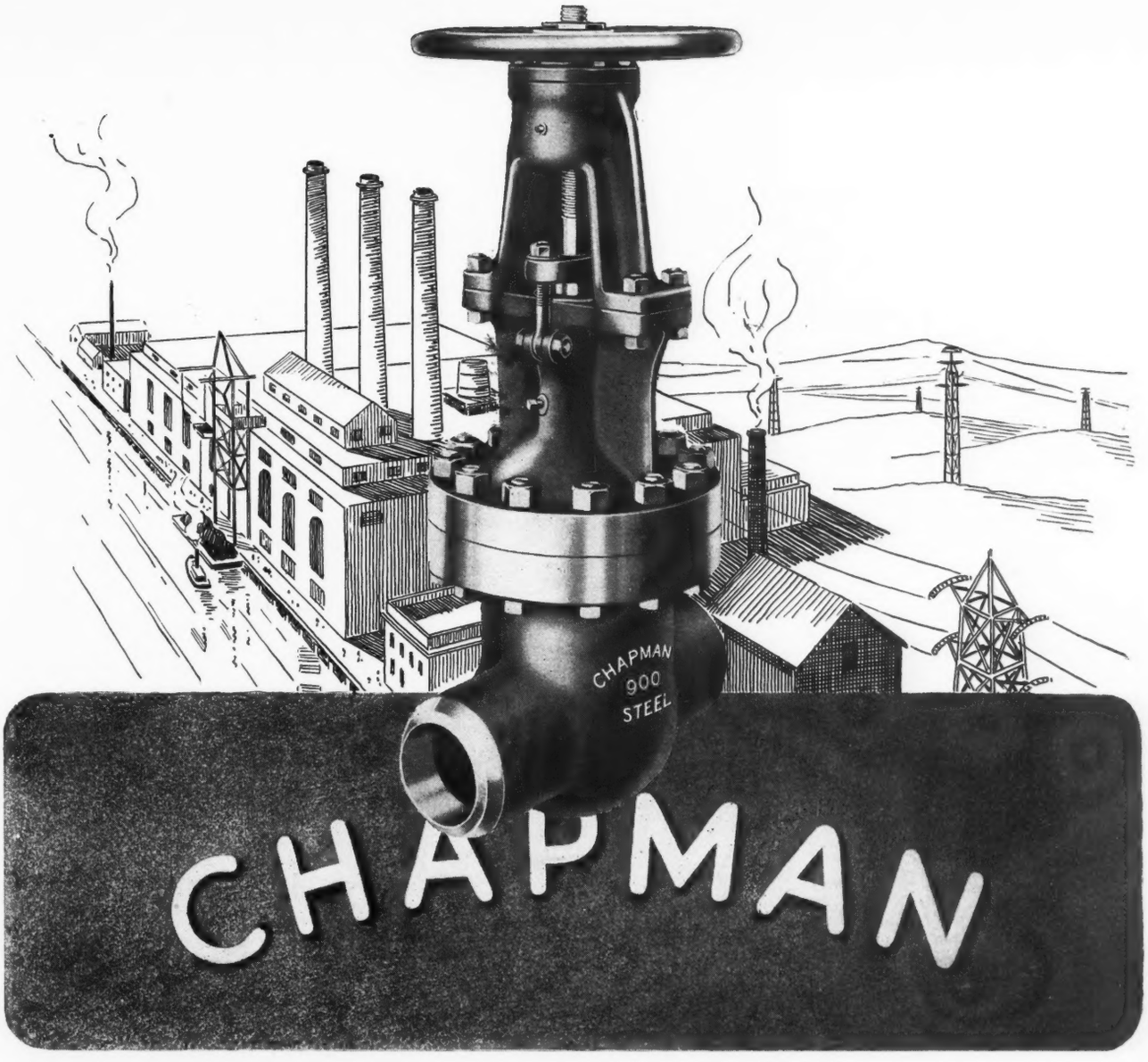
TYPE RHB-100, vertical, 4-cycle solid-injection diesels, are built in sizes 300 to 800 hp. Trunk-type pistons; Bosch injection nozzles and individual fuel pumps for each cylinder; heat-treated, die-pressed forged steel crankshaft machined at all bearings to secure uniform balancing and drilled for pressure lubrication; frames are semi-bloc construction containing two or three cylinders in a group; main bearings are babbit-lined, cylindrical-shell, split into halves; removable cylinder liners are cast of special nickel iron.

Chicago Pneumatic Tool Co, 6 E 44th St, New York, N. Y.









CHAPMAN

is the word for BETTER POWER PLANT VALVES

It's a word that's good usage in every language . . . for every high-temperature service. Because it's *kept* in good usage, right in the Chapman plant. To Chapman, good steel is precious metal, and always treated accordingly. Every melt is closely watched by experienced metallurgists. Every casting is finished by machinists trained to Chapman standards for years. And each valve is tested to unsparing requirements that leave no doubt as to what it will do for you . . . under temperatures up to 1000° F, and pressures to 1500 lb.

You can get dependable *Chapman character* in every department of plant operation . . . gate, globe, check and angle valves . . . with all types of operating mechanisms . . . in 7 special steels. So if you want to know "what's the good word" in valves . . . write "Chapman" on all your requirements.

CHAPMAN STEEL VALVES ARE MADE IN THESE ALLOYS

Carbon Steel • Carbon Molybdenum Steel • Chrome Nickel Steel • Nickel Steel • Chrome Molybdenum Steel • Chrome Tungsten Steel • Chrome Nickel Tungsten Steel

Chapman
POWER PLANT VALVES

THE CHAPMAN VALVE MFG. CO., Indian Orchard, Mass., U. S. A.

Readers' Problems

Questions for Our Readers

Red-Leading Tube Sheets

Question 1

WHAT *would be the effect, detrimental or otherwise, of red-leading interior front and rear tube sheets after they have been cleaned of any adhering scale? A friend of mine, in charge of heating plant in a moderate-size building, states that he did this red-leading recently at the close of the heating season, and also applied red lead to the tubes that could be painted. The boilers in his plant are return tubular, about 400 sq ft, and he usually operates the system at about 4-6 in. of vacuum. His idea is that the red lead coating will slow up scaling and pitting, especially in the tubes.*

It looks to me as though the red lead would wash off within a week or two after firing up. If the idea is practical, why isn't it tried in other small plants similar to his? I would like to hear the experience of POWER *readers on this interior red-leading of tube sheets and upper tubes*—AET

Phosphate Treatment

Question 2

OUR FEEDWATER *contains 25 ppm silica, 10 ppm iron, and 51 ppm of non-incrusting solids. Can some* POWER *reader tell me if phosphate will keep our boilers clean? If so, should it be trisodium or disodium phosphate? How should I figure the amount to be used?—JDO'N.*

Disabled Duplex Pump

Answers to July Question 1

The Question

Perhaps some reader of POWER *can answer a question asked me recently: "If one side of a duplex pump became disabled, how would one go about getting the other side to run?"—EMF*

Reduce Steam Pressure on Disabled Side

THE QUESTION as stated assumes the breakdown is in, say, the left side of the plunger or water end, so that the left steam end must be rigged to operate the remaining plunger and steam cylinder on the right side. This means making the left half of the pump run at the same speed as the right. The steam end of the left side, having no work to perform will tend to run at a much higher speed than the right side unless steam pressure operating this is reduced to give speed desired.

To accomplish this, run a pipe from the main throttle to the right steam chest, and from this pipe run another pipe, with a valve, to the left steam chest. The valve is throttled to reduce pressure in the left steam chest.

Berkeley, Calif. N C HURST

Tighten Glands

IF ANY PART of the steam end of one side of a duplex pump is broken, the other side cannot be made to run unless the broken part is replaced. However, if the plunger on one side is broken, and the rod is straight, the pump can be made to run by removing the broken plunger and tightening up glands on piston rod and plunger rod on the disabled side. This will create enough friction to prevent the piston striking the cylinder ends as it would with no opposition from the water end. Keep the two glands tight until a new plunger is fitted.

Fort William, Ontario P MORGAN

Change Valve Adjustment

REMOVE steam chest cover and place the nuts on the valve of the disabled side far enough apart so that the valve will only admit enough steam to move the piston through part of its stroke, thereby working the other valve. Replace steam chest cover and screw packing glands tight on disabled side to offer as much resistance as possible to the unloaded piston.

Edmonton, Alberta J L DAVIS

Exciters Will Not Operate in Parallel

Answers to July Question 2

The Question

Two of our exciters will not operate in parallel. One of them is rated 7.5 kw, the other, 12.5 kw. Both machines are compound-wound interpole, designed for 125 volts and run at 1200 rpm. One machine is about 40 ft from the busbars and the other about 70 ft. When we attempt to parallel these two units, a heavy cross current flows between them, the circuit breakers open and polarity of one or both the machines reverses! Can some POWER *readers tell me what is the trouble?—CRT*

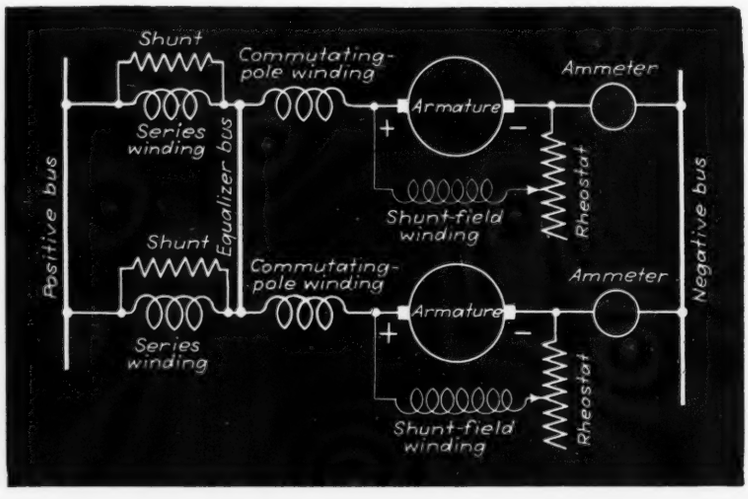
Improper Switching or Reverse Polarity

COMPOUND-WOUND commutating-pole generators will readily operate in parallel if the machines have similar electrical characteristics. The armature, commutating-pole winding and series-field winding must be connected in series in the order named and the equalizer connection made between the series field and commutating-pole windings as in the diagram. Resistance of the equalizer should be as low as possible and never greater than that of the generator leads to the busbar.

Most compound generators have a shunt connected in parallel with the series coils to adjust the compounding to the desired value. When machines to be operated in parallel have different compounding ratios, it may be necessary to readjust series-field shunts to get the same voltage at 25%, 50%, 75% and full load. Part of the load current goes through shunt and part through series winding. Sometimes the relation between the current in the two parts of the circuit changes because of a break in shunt laminations and loose or corroded series-coil terminals. Poor connections between series coils increase the resistance and reduce the current flow through them and increase the current through shunt or vice-versa.

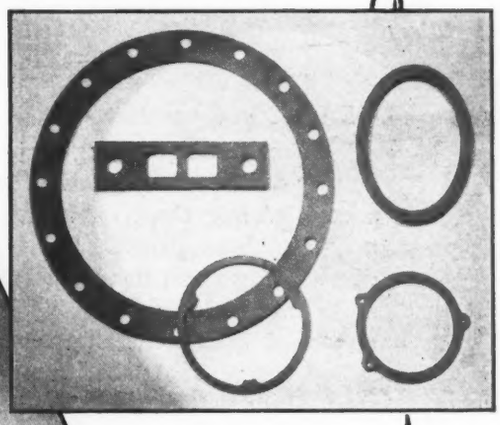
If one machine takes more than its share of load, increase the resistance of its series field circuit until load divides between machines proportionally to their

(*Continued on page* 110)



ADVERTISING PAGES REMOVED

STOP THOSE LEAKS!



Above — GARLOCK 122 Gaskets, cut from GARLOCK 22 Sheet. *Left* — GARLOCK 22 Red Rubber Sheet Packing. Supplied in thicknesses from 1/32" up to and including 1/4". Standard width of sheet is 40".

Use Garlock 22

ARE leaky joints a problem in your plant? Do you hear a *drip* . . . *drip* . . . *drip* . . . here and there? Stop those leaks on your hot or cold water and saturated steam joints with gaskets cut from GARLOCK 22 Red Rubber Sheet Packing. Made of finest materials, scientifically compounded, GARLOCK 22 gives long, dependable service at all pressures up to 150 lbs. per square inch.

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada Limited, Montreal, Que.

GARLOCK

School Days...

SEPTEMBER, and it's kinda sad to watch summer end. The kids are trying on scratchy new pairs of britches, forcing calloused feet into shoes, sort of sorrowfully hanging away their camping things.

Then, kinda grudgingly, they brighten up again, for tomorrow they start to school. They chatter like a bunch of magpies about pencils, copybooks, and who's going to sit in which seat—and it makes me remember back when another bunch of kids went through the same thing every September a long while ago. Only then it was slates and lunch buckets, and a long walk from school, with cows to be milked at the end of it. I can remember the new kid in the third row and how Skinny Hogan pasted him, Buck Heller's cracked tooth, Sandy's diving scar, Oscar Schlipp's fancy newfangled lunchbucket with the bottle in it, the blond girl who just moved into the big house in town, and Teacher's Pet Van Cherington bringing in his first big red apple.

Nature used to seem to pep up in September. Apples got redder, the corn was ready for shocking, and the pumpkins were turning yellow. Squirrels were busy storing up nuts, and the big red ants behind the spring house were toting away crumbs. There was a hint of weather in the wind at night, sort of forecasting October's coolness and November's eve of winter. And at home there was wood to chop, boughs to bank around the cellar, leaves to rake into a heap, windows to caulk.

Somehow or other, all that used to wake me up—still does in fact. I'll bet I make more resolutions—and carry more out—on September first than I do on January first. It's New Year for me every September. It's then I do my worthwhile planning for the winter, then that I figure on the new pump or the new stoker.

I'm suggesting you do the same, for business cycles pass just like seasons, and by the looks of things, we're going to be in for pushing out some kilowatts this fall. The lean times that let us loaf soon'll be over. Remember that nobody's figured out a way yet of storing kilowatts, like a squirrel stores nuts! Our only storehouse is capacity, capacity that is ready and willing, dependable and reliable. It's our responsibility to have it set to go when the time comes, whether the Boss sees the need now or not. If he doesn't, better lay plans, work out some figures, and prove to him that you're a squirrel, not a nut.

I hate to be a calamity howler, but if you're not ready, you'd better be about it. Maybe September does it to me, but I feel kind of like a guard in front of a storehouse, knowing that I'm guarding a reservoir of power that has to meet any need. And it will!

George Edwards

Engineer

CHAINED..

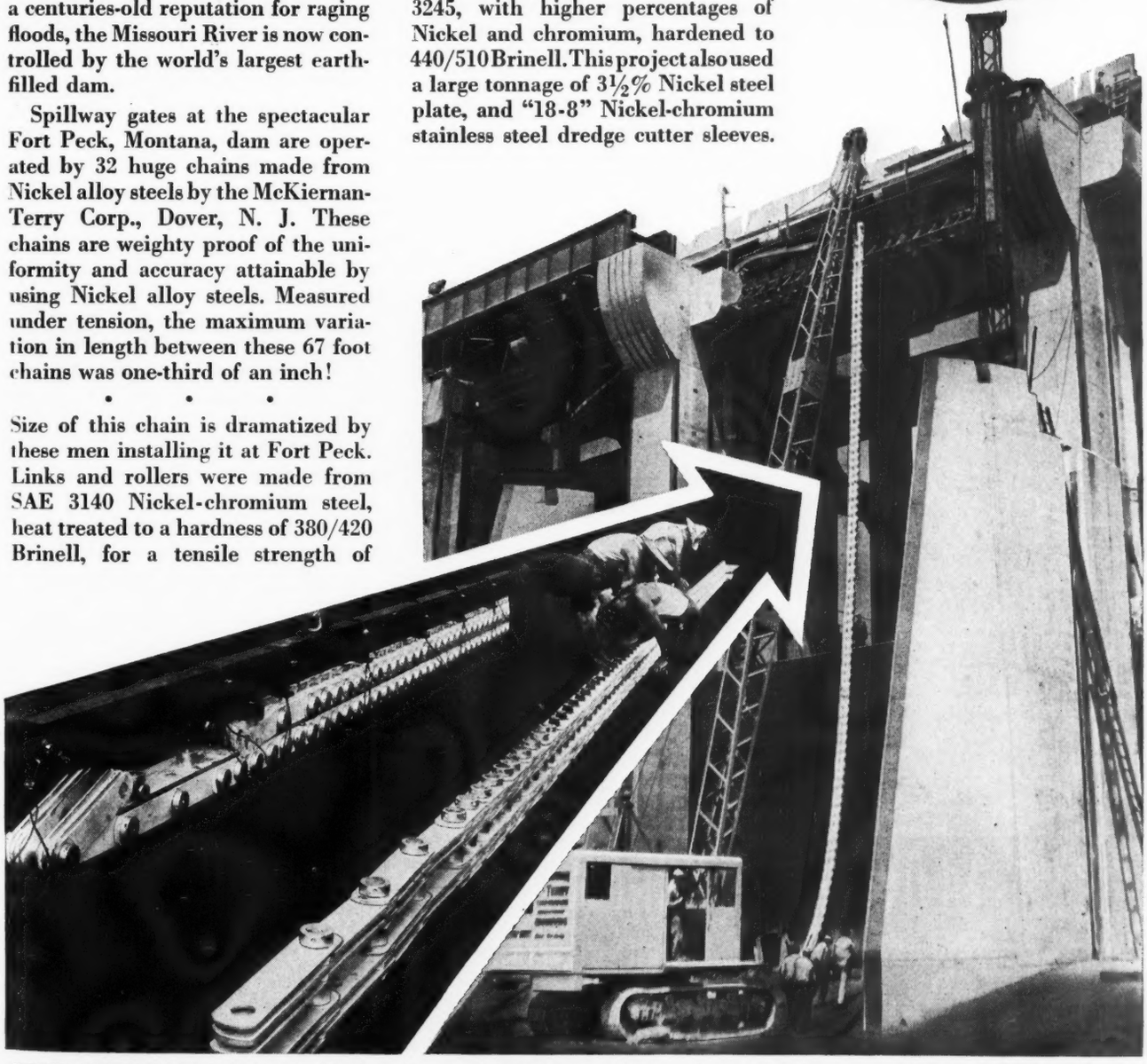
..THE RAGING MISSOURI by NICKEL ALLOY STEELS

Rushing down from the Rockies, with a centuries-old reputation for raging floods, the Missouri River is now controlled by the world's largest earth-filled dam.

Spillway gates at the spectacular Fort Peck, Montana, dam are operated by 32 huge chains made from Nickel alloy steels by the McKiernan-Terry Corp., Dover, N. J. These chains are weighty proof of the uniformity and accuracy attainable by using Nickel alloy steels. Measured under tension, the maximum variation in length between these 67 foot chains was one-third of an inch!

• • •

Size of this chain is dramatized by these men installing it at Fort Peck. Links and rollers were made from SAE 3140 Nickel-chromium steel, heat treated to a hardness of 380/420 Brinell, for a tensile strength of 180,000/200,000 p.s.i. Pins are SAE 3245, with higher percentages of Nickel and chromium, hardened to 440/510 Brinell. This project also used a large tonnage of 3½% Nickel steel plate, and "18-8" Nickel-chromium stainless steel dredge cutter sleeves.



THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK, N. Y.

-and in a few minutes

the valve seat was good as new!

It was refaced–in place–with a

• DEXTER

The pump had a leaky valve seat. It was wasting power and fuel. Yet with a DEXTER PUMP VALVE RESEATING OUTFIT the trouble was cured in a few minutes—and the pump left undisturbed. A DEXTER does the work with the machine in place. The cutters are self-leveling and cut a smooth true seat. Send for Catalog 24 describing this machine and the Dexter Machines for reseating globe valves and gate valves.

THE LEAVITT MACHINE CO.

10 EAST RIVER ST. ORANGE, MASS.

Canadian Distributors:—

The Canadian Fairbanks-Morse Company Limited

15 Branches Throughout Canada

Readers' Problems

(*Continued from page* 104)

capacity. For good results, all cables that lead from generators to busbars should have equal resistances. Therefore, different size wires should be used where distances vary or resistance should be inserted in cables with shortest distance or lowest resistance. This may be done by looping cables or inserting iron or German-silver washers under the connecting lugs.

It is my opinion that an attempt was made to parallel the machines in question when their polarities were opposite. Improper switching sequences sometimes cause trouble. The polarity of each generator to be paralleled should be checked before connecting it to the busbars. Bring machine up to normal speed, close equalizer switch first; when voltage is equal or slightly above line, close series-field line switch and then close the armature switch, when separate switches are used. If 3-pole switches are used, all three poles are of course closed at the same time. Watch voltmeter and ammeter and adjust field rheostat if necessary until machines take their share of load.

Chicago, Ill. WILLIAM W BELL

Machines Should Operate in Parallel

IT SEEMS that an attempt is being made to operate the generators in parallel without an equalizer. Such a connection must be provided before the machines will operate on the same busbars. I also suggest that the polarity of the shunt-, series- and interpole-field coils be checked. The equalizer connection should be made between the series and interpole windings and not between the interpole winding and armature.

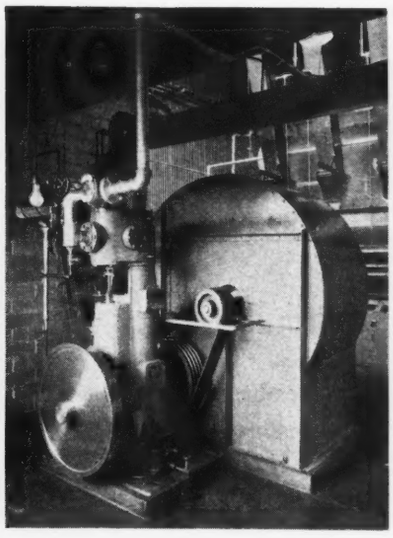
There is no reason why these machines should not operate in parallel, if they have similar characteristics. That they are located 40 and 70 ft respectively away from the busbars should not prevent obtaining satisfactory parallel operation, if the leads running to the switchboard are of proper size.

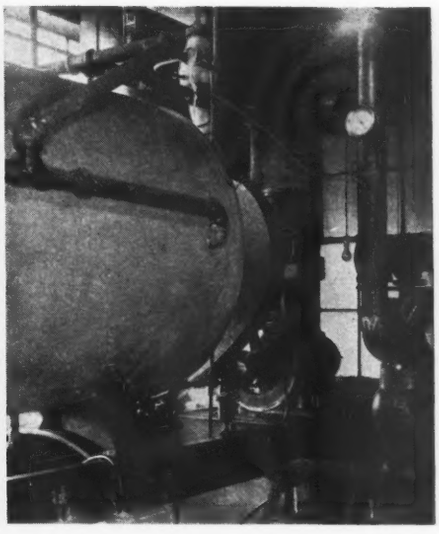
Latonia, Ky. DANA GIBSON

Experience With Welding Generators

I DO NOT KNOW very much about exciters, but I have had plenty of experience operating 8- and 12-kw welding generators in parallel. These machines are driven by every known means, such as gasoline engines, diesel engines, steam engines, belts, gears, chains and motors. A sure way to accomplish parallel operation is to connect the series-field coils of the 8-kw generator in series with the armature of the 12-kw generator and vice versa. A slight resistance connected in series with the 12-kw armature or a shunt across the series-field coils of

. . . and they continue to BUY!





Why? *Because they know that the TROY-ENGBERG STEAM ENGINE is a satisfactory drive and will save much in POWER COSTS*

Just the other day we received an order from one of the leading manufacturers of air-conditioning equipment for five medium size engines to drive compressors. Many times this company and others like it have purchased the Troy-Engberg Steam Engine for driving their equipment . . . not only compressors but pumps, fans, blowers, generators, cookers, etc. Many operating companies with other types of drives on existing equipment have changed over to this modern power unit.

Two basic reasons account for this preference:

1 For the type of work involved, the steam engine is the best drive. It offers high-starting torque with quick starting (no long warming-up period); its speed range is very wide and is responsive to automatic control; its conservative speed permits direct connection or low ratios; it can be operated without cylinder lubrication to give oil-free exhaust.

2 Costs are very low because the steam or water rate is very low and is maintained so for years; oil consumption is low; maintenance is negligible.

You don't have to wait until you buy new equipment to get the benefits of low-cost power which the Troy-Engberg Steam Engine delivers. You can change over to this type of drive for your present equipment. In sending for the Low Power Cost Survey shown below, tell us in detail the nature of the equipment on which you wish to reduce your power costs.

TROY ENGINE AND MACHINE CO.

Established 1870

1441 RAILROAD AVE., TROY, PA.

44 plants using Troy-Engberg Steam Engines selected at random, show an average power cost of only ½ cent per kwh . . . and *all costs* are included.

TROY ENGINE & MACHINE CO., 1441 Railroad Ave., Troy, Pa.

Gentlemen: Please send us a copy of Bulletin 101 which describes the results of the Survey referred to above.

Name and Title .....

Company .....

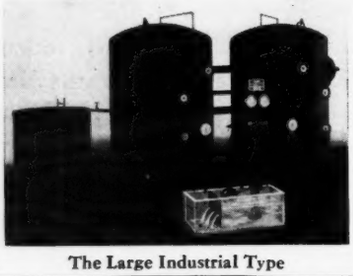
Address .....

SCAIFE

ZEOLITE WATER SOFTENERS

The Household Type

The Small Industrial Type



The Large Industrial Type

Prepare the Water Outside of the Boiler

What It Is:

A Scaife Base Exchange Water Softener is an external water softening device which permits water to pass through a bed of material having the unique property of being able to substitute its sodium for the scale forming elements contained in the water. As a result only very soluble, non-soap consuming sodium compounds remain within the water. Common salt reverses the process and revives the bed of material.

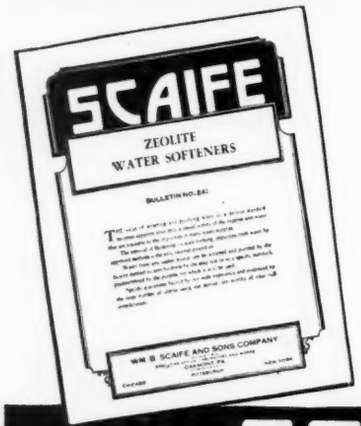
What It Does:

1. It makes water soft and non-scale forming.
2. It substitutes sodium for the scale forming elements.
3. It removes iron and manganese.

It does not affect the alkalinity or the total solids content of the water.

Where It Should Be Applied:

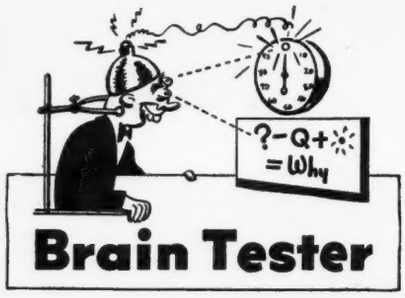
Zeolite softened water is a sodium water. Since the zeolite neither reduces the alkalinity nor the total solids, it naturally follows that the process should be applied to boiler waters low in bicarbonate hardness. The water being zeolited must be crystal clear and free from acidity. It also follows that the process is applicable regardless of non-carbonate hardness for those waters which are used in services requiring soap economy.



WM. B. SCAIFE & SONS CO.

OAKMONT (Pittsburgh District) PENNSYLVANIA

REPRESENTATIVES IN PRINCIPAL CITIES

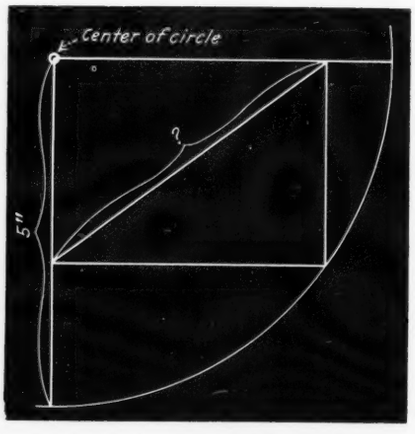


Brain Tester

Sharpen your wits on this little problem, then check your answer with the one given on page 114.

NEW ANGLE

"WHEN a tough problem has you licked, try tackling it from an entirely new angle"—that was a favorite maxim of the Old Chief. To drive his point home he would illustrate it with a little problem he had picked up somewhere. Sketching rapidly on a pad, he would make a quadrant of a circle with a rectangle in it, one corner of the rectangle being on the circumference of the circle. He would then give the radius of the circle as 5 in. and ask his listeners to give the length of the diagonal line



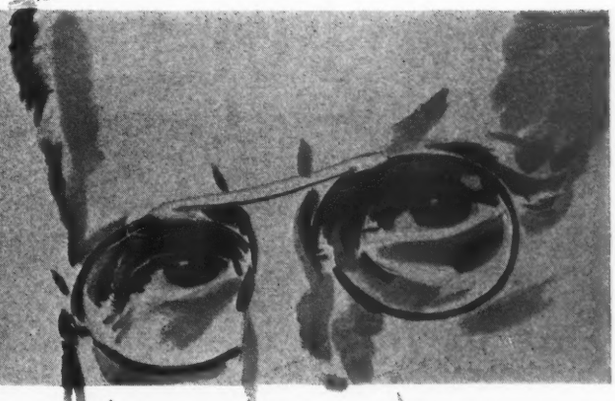
marked with a question mark (see sketch). Most would give up after looking at it futilely, others would give up after attempts at a written solution and a few would get it like a flash. Then the chief would show the unlucky ones how, and every one would be kicking themselves for not seeing it right away. What was the chief's new angle of attack?

---

the 8-kw machine will correctly adjust the load between the two machines.

I have also accomplished parallel operation by exciting the shunt-field coils of both generators from the larger generator. Excitation taken from the larger machine is more stable than that taken from the smaller unit, thus reducing tendency for current surges between the two machines. Adjusting the shunt across the series-field coils of the larger machines has sometimes been sufficient to make parallel operation successful. Selecting the series-field and equalizer cables of a resistance that

We go LOOKING for TROUBLE



When Scovill representatives go on their regular visits to customers, they look for trouble in heat exchangers. Their duty on those trips is to provide you with on-the-spot assistance.

A vast amount of material accumulated from that experience in the field . . . with the result that today the briefcase of every Scovill representative contains still another service — our Heat Exchanger Tube Manual. We believe it to contain more condenser tube information than any other single volume. Well do we realize that it could never have been produced, had you not helped us to look for and correct trouble . . . and so we hope you will always feel free to use the manual as your own source of engineering data.

But Engineering service and Engineering data would be valueless without an Engineered production to offer our customers, also. Scovill maintains a complete laboratory control over its extrusion, hot-piercing and cup-drawing processes of manufacturing condenser tubes. Not only are Scovill tubes made to a timed schedule, but they must meet the requirements of specifications as covered by 15 tests before release from the Scovill plant.

How they are made, complete descriptions of the tests given them, and other interesting material from the Scovill manual is contained in an informative book, *Scovill Condenser Tubes*. We invite you to write for it, addressing Scovill Manufacturing Company, 13 Mill Street, Waterbury, Connecticut.

A power plant condenser showed rapid localized erosion and corrosion in five distinct areas. Examination by a Scovill engineer led to the recommendation of a simple change in construction. As a test the change was made over a few of the areas, the others were left as before. All five areas were then retubed.

Where the change was made the corrosion and erosion condition disappeared, the other tubes failed as before.

The change has now been made on the other areas and the localized rapid corrosion has been completely eliminated.

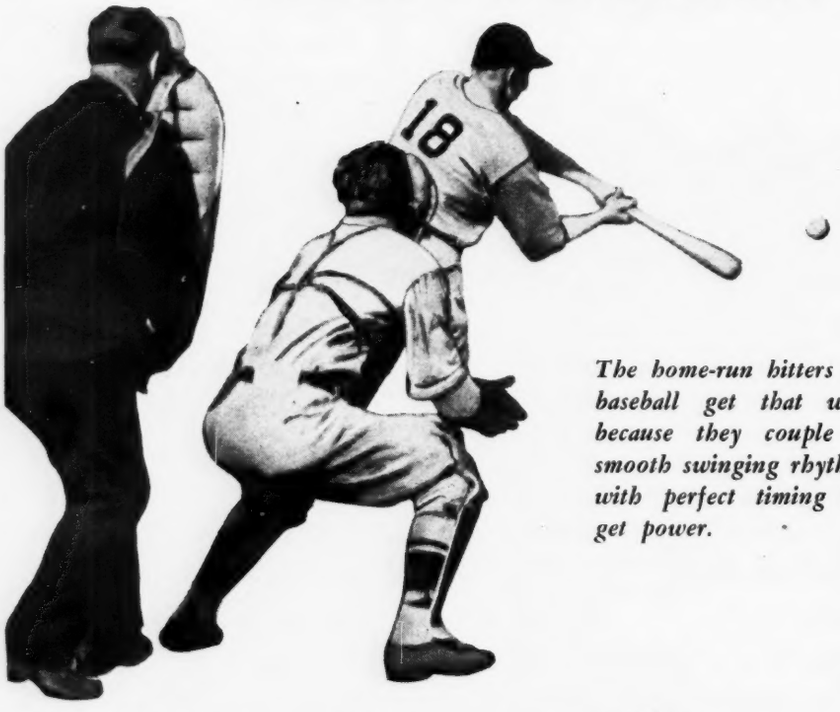
SCOVILL

Masters of Metal

Scovill Condenser Tubes

one product . . . three services

Smooth PERFORMERS!



The home-run hitters in baseball get that way because they couple a smooth swinging rhythm with perfect timing to get power.

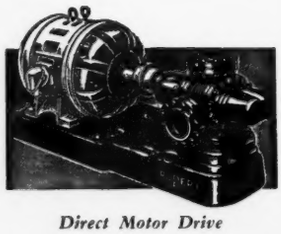
• We think the same qualities are needed in pumps . . . and that's the way we build them.

Roper Pumps have the balance and accurate timing to give perfect smoothness of operation . . . unencumbered power.

In your plant you'll find Ropers have a little more zip . . . an extra measure of power . . . a longer service life . . . with less upkeep cost.

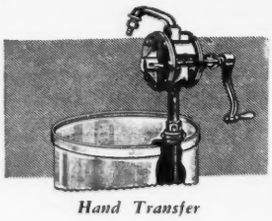
We have built pumps for 80 years . . . and have always aimed to build the best ones. We've had time enough to learn how!

Your request for proof will bring Bulletin P1 with prices and complete details.



Direct Motor Drive

Motor Drive Thru Reducing Gears



Hand Transfer

Geo. D. Roper Corporation, Rockford, Illinois

ROPER *Rotary* PUMPS

DEPENDABLE · SINCE 1857

would cause a current division in a ratio of 8 to 12 between the two machines has also met with success.

Newark, N. J. C J HOLSLAG
Electric Arc Welding & Cutting Co

Trouble May Be In Equalizer Connections

A POOR CONNECTION or an open circuit in the equalizer would cause unstable operation of the two machines and cause one to tend to take all the load. Resistances of the series-field circuits may not be inversely proportional to the capacities of the machines. This would cause the machine with the lowest resistance in its field circuit to carry the most load, a condition that can be remedied by inserting resistance in series with the proper field circuit to secure the desired resistance ratio. Poor equalizer connections cause a change in this resistance ratio.

The exciters may have different amounts of compounding, thus giving them different external characteristics. The exciter having the most compounding takes the larger share of the load. Compounding can be changed to give the same characteristics to both machines by adjusting the series-field shunts, by shifting the brushes.

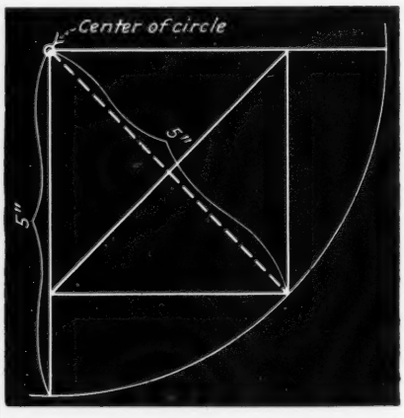
Exciters may not be switched together properly. Proper operation requires the equalizer and series-field circuit to be

---

BRAIN TESTER

Answer to problem on page 112.

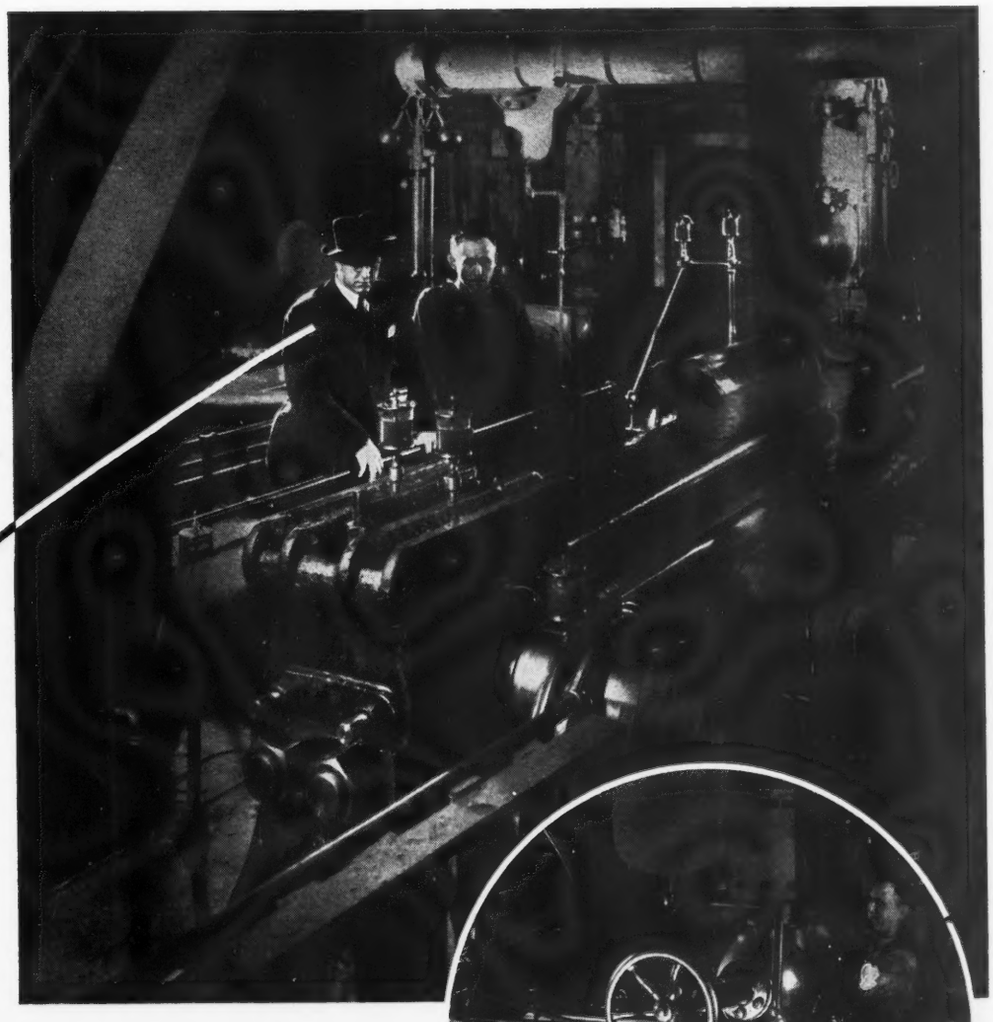
FIRST thing the chief did was sketch in the other diagonal of the rectangle, as shown by the dotted line in the sketch. Just about this time, the answer would jump up and hit the boys in the face, because they could all see that the dotted line was another radius, and so was 5-in. long. Remembering that diagonals of a rectangle are equal in length they



gave 5 in. as the answer to the Chief's problem. "You've just got to look at the thing until something clicks and you see that other diagonal there", the Old Chief would wind up, "and you've got to go at your other problems until something clicks and you see the new angle of attack, the right approach".

"Since 1912, GULF OILS have helped us keep these engines in tip-top running order"

...SAYS THIS PLANT ENGINEER



"This GULF ENGINEER gives us the right recommendations"

"THE last time the inspector looked over these engines he stated that the cylinders and bearings were in perfect condition. We give Gulf oils and the recommendations of the Gulf engineer a lot of credit for the fine service we get from this old equipment," says this plant engineer.

For steam engines, old or new, the Gulf engineer is prepared to recommend the type of lubricants which will help them give such outstanding service as these two engines have given in this plant for 26 years. After a careful study of the conditions under which your engines operate, he will recommend the lubricants which best provide for the conditions encountered.

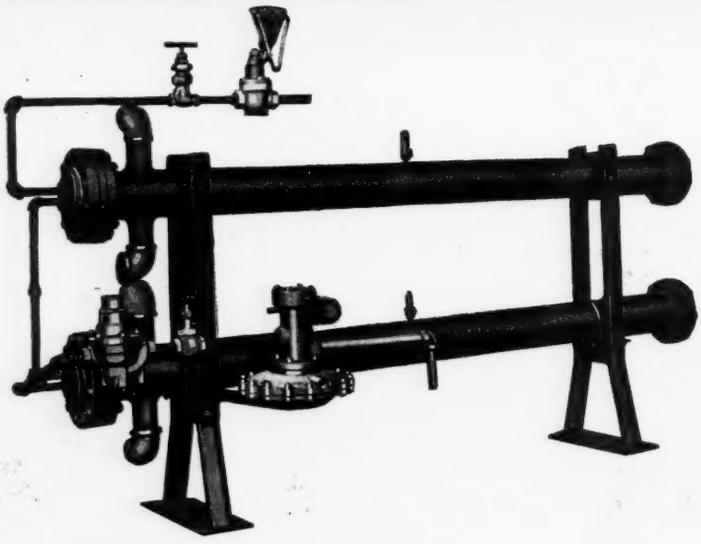
The next time a Gulf engineer calls at your plant ask him to check over your equipment and suggest possible improvements in lubrication practice. There is no charge for this service and you may secure benefits from his suggestions—in lessened wear of engine parts and lowered costs for maintenance.

GULF OIL CORPORATION
GULF REFINING COMPANY
GENERAL OFFICES: GULF BUILDING, PITTSBURGH, PA.

GULF INDUSTRIAL LUBRICATION

Listen to the new Gulf radio program—THE PASSING PARADE, with John Booth Nesbit—every Sunday evening, Columbia network.

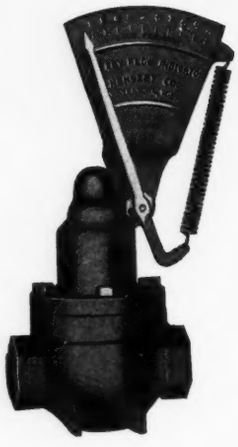
Complete, Automatic
BOILER BLOWDOWN



That's what you get with

HENSZEY CONTINUOUS BLOWDOWN

This system offers complete automatic control of Boiler water impurities—eliminating the common boiler troubles of priming, foaming and the formation of scale. The outstanding feature of this system is the fact that this can be accomplished without heat loss!

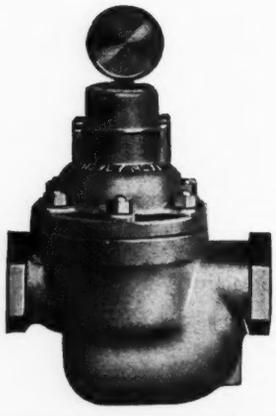


FLOW INDICATOR

For steam, water, and other fluids this accurate instrument goes right in the pipe line. Simple in construction and principle of operation, there are no complicated parts to get out of order. Sanitary model meets all requirements for milk and other food fluids.

FEED WATER METER

While this accurate meter is primarily designed to measure boiler feed water and blowdown, it has been successfully used with other liquids that are ordinarily difficult to measure.



Send for literature

HENSZEY COMPANY

Dept. D-9, Watertown, Wis.

HENSZEY

BOILER WATER CONCENTRATION CONTROL SYSTEMS

connected first, bringing the incoming machine to bus voltage, then closing the remaining line switch and regulating the shunt-field rheostat to suit conditions.

As a rule, with the equalizer in circuit, reversal of field-pole polarity is not likely to happen when paralleling. Reversal of polarity at this time, if it does occur, is generally caused by self induction of the field coils when load current is suddenly interrupted or by armature reaction during short circuits.

New York, N. Y. MILTON N KRAUS

Machines Require Equal Compounding

FROM THE information given and a similar experience, I would say that the two exciters do not have equal compounding. This is necessary, and they must have the same voltage at no load. Due to saturation of the magnetic circuit, it is not always possible to make the compounding curve of each machine a straight line, that is, make the increase in voltage directly proportional to the load.

The compounding curves of these machines should be checked before an attempt is made to operate them in parallel. These curves may be obtained from the manufacturer of the machines or plotted from actual tests of the generators at the plant. If the compounding of the two machines is not the same, it will perhaps be advisable to divide the busbars so that an exciter can be connected to each alternator.

Waynesboro, Va. J M MYERS

Current Comment

(*Continued from page* 85)

pitting. To avoid the expense of retubing with new tubes, a practice known as "safe-ending" may be employed, common in railroad shops and often used in stationary work. The tube is removed, the thin end cut off, and a new end of proper thickness and length is forge welded or electric-resistance butt-welded and rolled at welding heat to the cut end. The tube is then replaced in the boiler.

This practice is perfectly proper and acceptable under recognized codes, as applied to fire tubes only, and if done by a capable welder whose work meets specified tests. The number of tubes which may be safe-ended is limited under certain conditions.

Undoubtedly in the case mentioned by Mr Rudbeck, the scale scraping was performed during an opportune time—while the tubes were removed for safe-ending.

Canton, Mass. HARRY M SPRING

Drives for Pumps

IN VIEW of your introductory statement on page 80 of June *Power* that "modern pumps are usually driven by steam tur-

WHERE TO USE THIS CRANE CHECK VALVE

...IN POWER PLANTS AND FACTORIES

Lift check valves with composition discs are especially suited for service where discs must be renewed easily and quickly. They may be used on steam, air, gas and other vapor lines—provided that flow is not subject to severe pulsations. But that's about as far as general working principles can be applied in check valve selection—be it composition or metal disc lift check, cushioned disc, swing type—or any of their many variations.

Check valves can't be picked by a formula. Crane makes more than 90 types—each designed for a specific service. What type is best suited to your needs and where to use composition or metal discs in lift or swing type valves can be decided only by thorough knowledge of check valves and experience in their use. Your Crane Representative is specially trained in the solution of back-flow control problems. He can offer the valve that is exactly matched to your requirements.

It's What's Inside That Counts!

It goes without saying that satisfactory performance of check valves depends on their quality as well as on selection of the proper type. Crane-Quality, backed by more than 80 years of manufacturing and valve engineering experience, is your assurance of superior goodness in Crane Check Valves all the way through—of proper design to perform efficiently, built right to give lasting service.

"Checking Up on Check Valves"

This new Crane booklet gives a lot of valuable information on the Crane line of check valves for every application. It contains the handy reference guide illustrated above. Write for your free copy today.

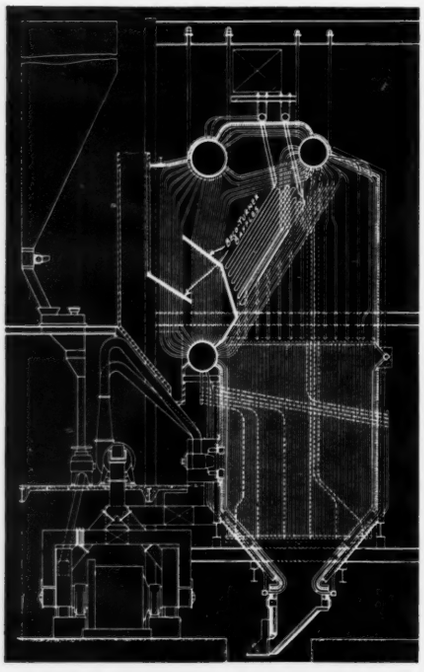
CRANE

VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

CRANE CO., GENERAL OFFICES: 836 SOUTH MICHIGAN AVENUE, CHICAGO, ILLINOIS

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL IMPORTANT CITIES

BECO-TURNER BAFFLES



For 300,000 lb. Boiler
at Indianapolis Power & Light Co.

TWO new 300,000 lb. per hr. Foster Wheeler steam generators were recently installed at the C. C. Perry Section K plant of the Indianapolis Power & Light Co. The print above shows the Beco-Turner cross baffles installed in connection with these boilers.

Beco-Turner cross baffles increase the efficiency of bent-tube boilers. With conventional parallel baffles, the gases flow *along* the tubes. With Beco-Turner cross baffles, they flow *across* the tubes, resulting in more efficient heat transfer to the boiler.

Beco-Turner baffles improve the performance of all types of water tube boilers. Our new 44-page catalog, "Plibrico Boiler Setting Construction for Water Tube Boilers", covers the application of Beco-Turner baffles for bent-tube and other important types. Mail coupon for your copy. Send blueprints for our recommendations for improving your baffle design.

Plibrico Jointless Firebrick Co.

Nation-Wide Boiler Setting Service

BAFFLE DEPT. CHICAGO, ILL.

MAIL COUPON FOR FREE CATALOG

Plibrico Jointless Firebrick Co.
1818 Kingsbury St., Chicago, Ill.

P9-38

Mail copy of "Plibrico Boiler Setting Construction for Water Tube Boilers" covering Beco-Turner baffles.

Firm .....

Address .....

.....

Name ..... Title .....

Send blueprints for baffle recommendations

bines, internal-combustion engines or electric motors," you may be interested to know that of the last 100 Troy-Engberg steam engines sold, 22 were for driving pumps. Since the modern steam engine has suitable characteristics for practically any auxiliary drive, this 22% indicates that many still consider steam engines as a drive for pumps.

Troy, Pa. F J VONACHEN
Troy Engine & Machine Co

High Temperatures in Air Compressors

BANQUO'S GHOST, in his refusal to down, is a piker compared with the notion that leaking discharge valves are the cause of high temperatures sometimes found in air compressors. The reasoning seems to be: there is a high discharge temperature, an examination discloses leaking discharge valves; therefore, the leaking valves cause the high temperature.

Considering the many thousands of air-compressors in constant use, excessive temperature is a rare occurrence. Attributing high temperature to leaking valves, therefore, seems to imply that air-tight valves, to say nothing of piston rings, are assured. Really, the opposite is true, for perfect tightness is far less common than generally assumed. I have personally directed overhauling of several badly leaking compressors, and in no case was there an abnormal discharge temperature.

Some people, in computing the discharge temperature allegedly due to leaking valves, use the equation:

$$\frac{T_2}{T_1} = \frac{P_2^{\frac{n-1}{n}}}{P_1}$$

and with 80 lb pressure and a value of 1.41 for n, find a temperature of 450 F at the end of the first compression stroke, handling atmospheric air. This would be true enough if there were no heat radiation to the atmosphere or conduction to the coling water. Then, disregarding dilution with fresh, cool air entering the cylinder on the second suction stroke, they find at the end of the second compression stroke a temperature of about 1100 F, declared to be dangerous. If calculation had been continued to the third stroke, temperature would have been 1500 F, and for the fifth stroke about 5300 F. By this time, we can well wonder why the compressor isn't red-hot.

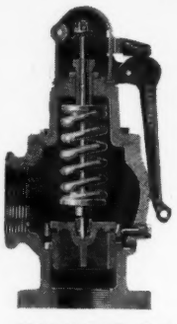
Several factors preclude such abnormal temperatures. First, practical operation reduces the exponent n from 1.41 to about 1.30 through radiation and conduction; that is, compression is somewhere between isothermal and adiabatic. Second, leakage air is diluted with a large volume of cool air entering the cylinder with the suction stroke. And third, high-pressure air leaking into the cylinder does work on the piston and on the air; consequently, loses a proportionate amount of its heat.

In the automatic-clearance-control compressor, in which, when there is no

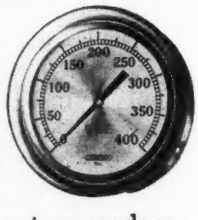
PERFORMANCE *Plus*
- that's LONERGAN

All LONERGAN Valve Seats are passed through the Lonergan Lapping Process to insure tightness.

The LONERGAN Whip Test has been conducted on the same Lonergan Gauge, 82 pulsations a minute, 8 hours a day, since July 22, 1936. This gauge is still in perfect condition—undeniable proof of the stamina and inbuilt supremacy of LONERGAN Gauges.



MODEL WT (Left)
POP SAFETY VALVE
A. S. M. E., Iron Body, Bronze Mounted. Designed for Water Tube and all types of boilers. Relieving capacity based on sustained lift of disc. Positive in action—opens and closes sharply.



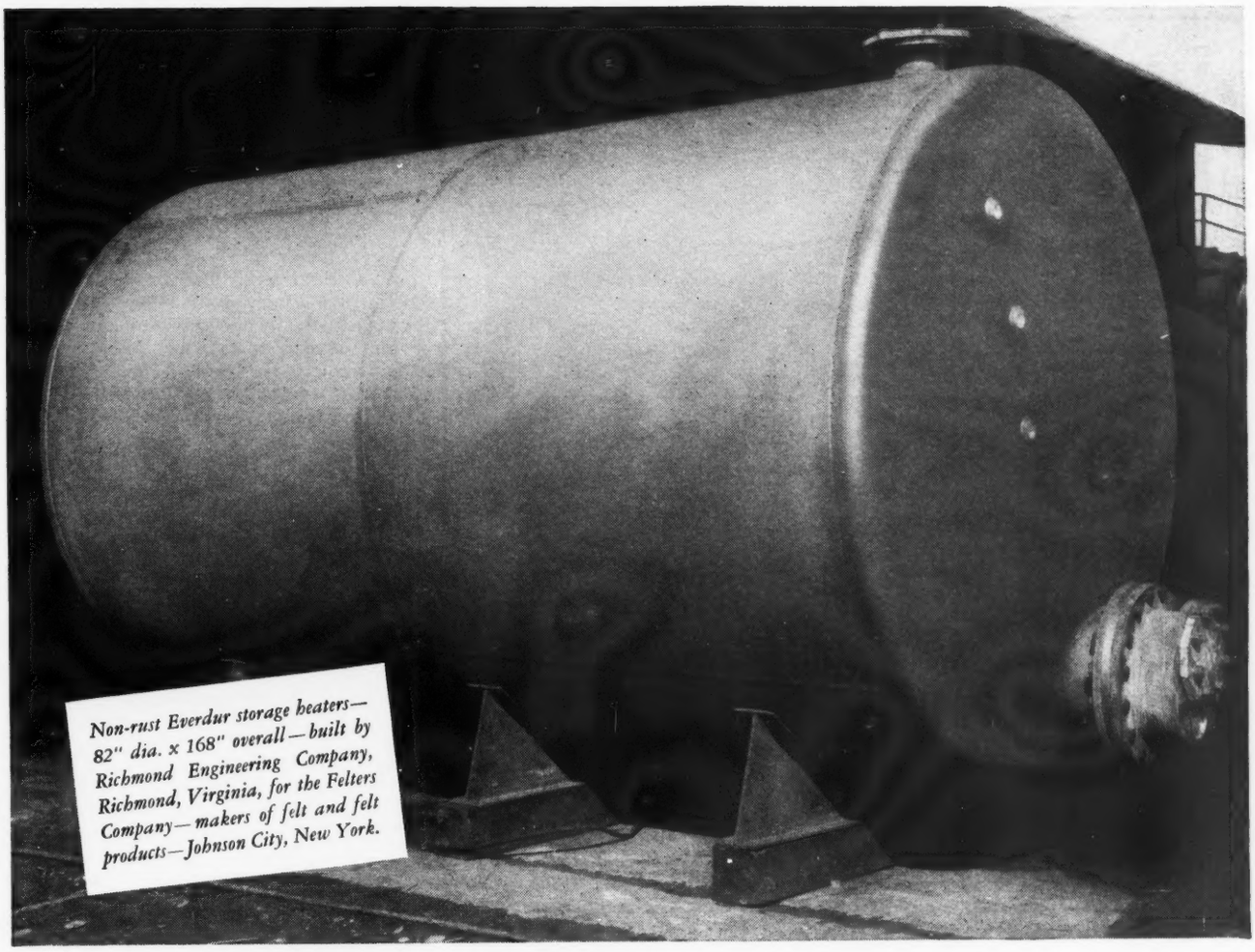
MODEL BOE (Right)
PRESSURE GAUGE
Standard single seamless drawn Bourdon tube gauge of "Super-Service" type. Graduated to any pressure from 15 to 1000 lbs. Standard sizes up to 12". Connection, all sizes, ¼" pipe thread.

For new equipment or replacements it pays to standardize on Lonergan Power Plant Safety Appliances. See your local distributor or write us direct.

J. E. LONERGAN CO.
SECOND & RACE STS., PHILADELPHIA, PA.

300 Specialties for Power Plants
Standard Since 1872

Lonergan
VALVES • GAUGES • SPECIALTIES



Non-rust Everdur storage heaters—82" dia. x 168" overall—built by Richmond Engineering Company, Richmond, Virginia, for the Felters Company—makers of felt and felt products—Johnson City, New York.

Industry after Industry replaces rustable tanks with Everdur

EACH YEAR more and more plant and property owners discover the real economy of Everdur Copper-Silicon Alloy for hot water storage heaters. For Everdur heaters not only eliminate the periodic, expensive burden of rust-repairs, and eventual replacement due to rust...but they also assure lasting freedom from red, rusty hot water.

The wide acceptance of Everdur for heater shells is indicated by its extensive use in the processing industries, and also in laundries, hotels, hospitals, public buildings, schools and homes.

Ideal for heaters

Everdur is ideal for durable heaters. It is rustless as copper, exceptionally strong and can be easily welded for the most efficient type of tank construction. Everdur tanks and heaters of all types and sizes are obtainable from leading equipment manufacturers. 3898

Everdur TANK METAL ANACONDA from mine to consumer

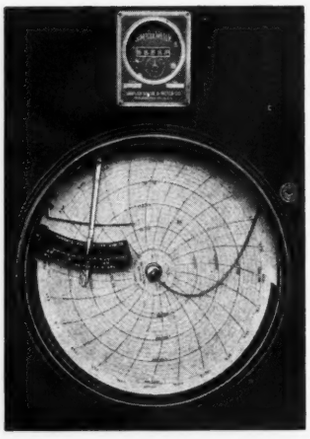
THE AMERICAN BRASS COMPANY, General Offices: WATERBURY, CONN.
In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • Subsidiary of Anaconda Copper Mining Co.

EVERDUR is a trade-mark of The American Brass Company, registered in the United States Patent Office.

WHEN THERE MUST BE NO DOUBT

concerning the accurate measurement of

BOILER FEED
CONDENSATE
EVAPORATE
MAKE-UP
STEAM



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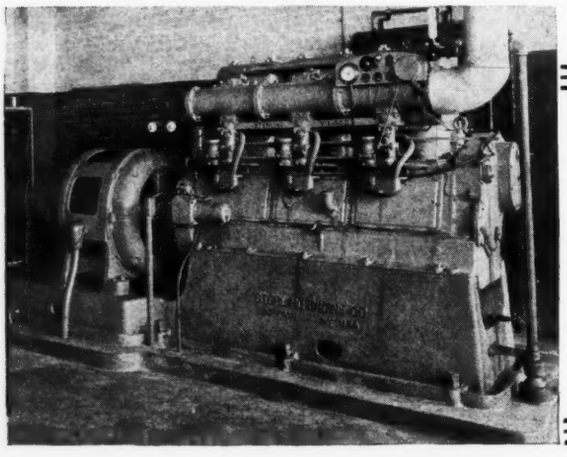

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demand, air leaving the cylinder passes into pockets of sufficient volume to insure closure of the suction valves, while the piston compresses and recompresses the air until there is a demand, whereupon normal operation is resumed. If the compressed air in this case did not do work on the piston, with consequent refrigeration, then overheating should occur in a few strokes. This type of compressor is successful, and there is no overheating.

If the condition of valves in an air compressor is not responsible for high temperature, what does cause fires in piping and receivers? That there are fires is evidenced by occasional red-hot piping and receivers. And in overhauling compressors in which overheating had not even been suspected, deposits varying from soot to clinker-like substances are sometimes found.

Here is an opportunity for research, and pending definite results from investigation, speculation seems vain. We do know, however, that in the absence of fuel there can be no fire; therefore, use only the quantity and quality of lubricating oil recommended by the manufacturers. And means should be provided for the unfailing drainage of water and its burden of oil from the receiver. We also know that under the dense condition of the air, a fire burns fiercely, once started. But before combustion can begin, there must be a kindling or ignition temperature. The cause of this temperature should prove an interesting and fruitful subject of research.

In my opinion, overheating is produced by a number of contributing factors that, on rare occasions, coincide to produce high temperature. If a single factor were responsible, there would be numerous cases of overheating and the single cause would long since have been brought to light.

Los Angeles, Cal. C O SANDSTROM,
Consulting Engineer

STRAWS

(Continued from page 88)

plant near Clinton. Cost over $100,000.

Dowagiac contracted W G Winwright, Marshall, for reconstruction of municipal power-plant building at $19,740, exclusive of equipment.

MINNESOTA——Princeton will award contracts soon for equipment for municipal electric plant, for which fund of $120,000 has been arranged. Burlingame, Hitchcock & Estabrook, Sexton Bldg, Minneapolis, consulting engineers.

Board of Education, Albert Lea, plans central-heating plant for 3-story senior and junior high school. Cost about $500,000. Financing through bond issue and Federal aid. Bids will be asked soon. Toltz, King & Day, Inc, Pioneer Bldg, St. Paul, architects.

Madelia contracted Fairbanks, Morse & Co, Chicago, Ill., at $139,952 for equipment for municipal electric plant. Burlingame, Hitchcock & Estabrook, Sexton Bldg, Minneapolis, consulting engineers.

MISSISSIPPI——Centerville plans pipeline system for natural-gas distribution, including 2-in welded-steel pipeline for connection with line on Inter-State Natural Gas Co, which will furnish supply. Cost about $37,000. Financing has been

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For full particulars, please write for descriptive Bulletin 1510-P.

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ELECTRICAL INSTRUMENTS

1211-13 ARCH STREET PHILADELPHIA, PA.

completed through Federal aid and work will begin soon.

Meridian has secured Federal grant and loan totaling $1,418,000 for new municipal electric plant, to include 7500-kw turbine-generator, boiler unit and auxiliary equipment.

MISSOURI——Rockport will award contracts soon for equipment for municipal ice-manufacturing and refrigerating plant. Cost about $35,000. Engineering Service Co, Railway Exchange Bldg, Kansas City, consulting engineer.

Board of Trustees, Southwest Missouri State Teachers' College, Springfield, plans extensions in power house at institution. $418,100 being arranged for this and other work at college, including several new buildings.

Caruthersville plans municipal electric plant of 600-kw capacity, using diesel-generating units and accessories. Cost about $175,000. Financing through Federal aid. Work scheduled to begin soon.

NEBRASKA——Lincoln will take bids soon for improvements in municipal electric plant, including new boiler units and auxiliary equipment. Cost about $175,000. D L Erickson, city engineer.

NEW JERSEY——Water Bureau, Camden, plans pumping plant for municipal water system, using diesel-driven pumping units and accessories. Cost about $385,000. Financing through Federal aid.

NEW YORK——National Gypsum Co, 190 Delaware Ave, Buffalo, plans power house at new wallboard mill at Savannah, Ga. General contract for plant let to George A. Fuller Co, 597 Madison Ave, New York, and work scheduled to begin in Sept. Entire project will cost $1,000,000.

Queensboro Refrigerating & Terminal Corp, 93-03 Sutphin Blvd, Jamaica, L. I., has approved plans for new 6-story cold-storage and refrigerating plant, 65 x 225 ft. Cost about $300,000. Work is scheduled to begin at once. Frederick O Lewis, 51 E 42nd St, New York, architect.

NORTH CAROLINA——City Council, High Point, E M Knox, city manager, plans central-heating plant in new municipal hospital, consisting of several buildings. Cost about $325,000.

Pitt County Board of Education, Greenville, plans remodeling and expanding central-heating plant at Farmville for service in other schools in that area. New boiler units and auxiliary equipment will be installed. Cost close to $50,000.

Board of Trustees, University of North Carolina, Chapel Hill, plans improvements in power plant at institution, including installation of new 5000-sq ft boiler unit, with stoker and accessories, 1000-kw turbine-generator, with condenser and auxiliary equipment, spray pond, coal conveyors and other equipment. Cost about $306,000, of which $137,925 will be a Federal grant.

NORTH DAKOTA——Standing Rock Indian Agency, Dept of Interior, Fort Yates, will award contracts soon for equipment for new central-heating plant.

OHIO——Piqua plans expansion in municipal electric plant. Cost about $480,000. Financing through Federal aid. Burns & McDonnell Engrg Co, 107 W Linwood Blvd, Kansas City, Mo., consulting engineer.

Board of Directors, Wooster College, Wooster, will place contracts soon for equipment for new power house at institution, including three 3780-sq ft boiler units and accessory equipment, one 300-kw and one 150-kw electric generators, pumping machinery and auxiliary equipment. Cost about $250,000.

Deshler plans rebuilding of portion of municipal electric plant recently destroyed by fire. Loss about $50,000, including damage to diesel and other equipment.

Jaeger Machine Co, 550 W Spring St, Columbus, is considering new power house at plant. Cost close to $50,000, with boiler units and auxiliary equipment.

Fairport is arranging fund of $155,000 through Federal aid and bond issue for municipal electric plant, to include three 200-kw diesel-generator units and auxiliary equipment. Proposed to begin work

HERCULES

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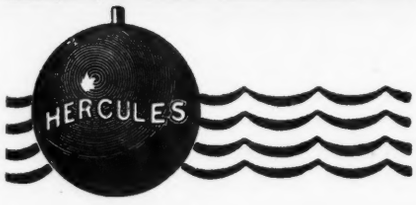
FLOATS



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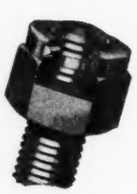

Fig. 1510

Cutout Section Showing Locking Ring in Place.

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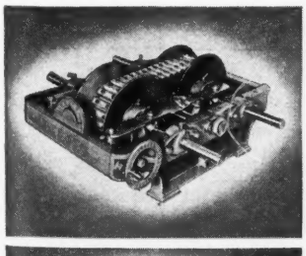
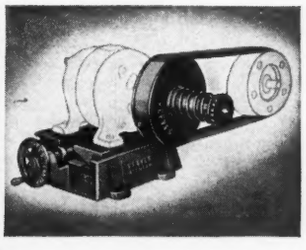
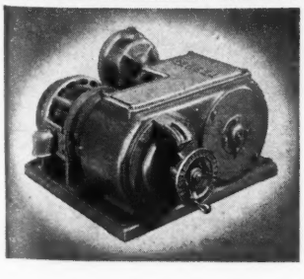
If conditions in the buyer's plant were always the same—if there were no variation in materials—no difference in types and sizes of product—no occasion to synchronize machines or processes—if all operators had equal experience and ability—there might be little need for variable speed control of production machines.

But we all know that these variables *do occur.* And the machines that turn out the best work, the most work—*or both*—are those which the *operator can adjust,* easily and accurately, for the exact speed required.

There is no compromise between quality and quantity on a machine which is equipped with REEVES Variable Speed Control. Simply by turning a handwheel the operator secures any speed he needs—even to a fraction of an r. p. m.—and that speed is *accurately* maintained until changed. REEVES Variable Speed Control is not expensive. . . . Builders of 1,300 different machines find one or more of the three basic REEVES units exactly meet their requirements. Designed for horizontal or vertical mounting. Automatic or manual control. Easily applied to any driven machine. Write us.







Pictured at left are the 3 Basic REEVES *units: the Variable Speed Transmission, the Vari-Speed Motor Pulley and (below) the Motodrive, the complete variable speed power plant.*

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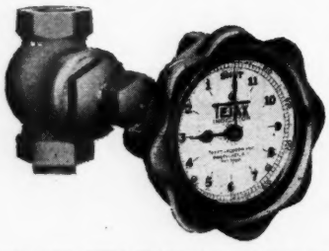

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Data sheet No. 41 shows how four Fyr-Feeder equipped plants have made savings averaging 31.7% even though all four plants previously had stoker equipment. Write for your copy of this interesting sheet and bulletin 77 which describes the Fyr-Feeder in detail.

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soon. Robert M Jones, Akron, consulting engineer.

OKLAHOMA——Cleveland has plans maturing for municipal electric plant, using diesel-generating units of about 540-kw capacity, and auxiliary equipment. $142,000 has been arranged through Federal aid.

Blackwell plans extensions in municipal power plant, including new 4000-kw steam turbine-generator and auxiliary equipment. Cost about $207,000. Appropriation has been secured through Federal aid.

Okmulgee plans municipal electric plant of 3300-kw capacity, using diesel-generating units. Cost about $900,000.

PENNSYLVANIA——Board of Public Education, Administration Bldg, 341 Bellefield St, Pittsburgh, plans central-heating plant in 5-story vocational school at Sarah and 25th Sts. Cost about $1,100,000.

Scott Paper Co, Chester, plans expansion in power house at paper mill in connection with extensions in plant for increased paper production. Entire project will cost close to $3,000,000.

TEXAS——Weslaco plans municipal electric plant, using diesel-generator units. Cost about $180,000. Financing has been arranged through Federal aid and work is scheduled to begin soon.

Gonzales plans municipal electric plant, using diesel-generating units. Cost about $175,000, of which $78,000 will be Federal grant. Garrett Engrg Co, 308 Hughes St, Houston, consulting engineer.

Texarkana plans municipal electric plant, using diesel-generator units. $545,000 secured through Federal loan and grant. Joseph E Ward, Harvey-Snider Bldg, Wichita Falls, consulting engineer.

Centerville plans electric pumping equipment and accessories, with 50,000-gal elevated steel tank and tower for extensions and improvements in water system. Cost about $54,000. Financing through Federal aid. Garrett Engrg Co, 308 Hughes St, Houston, consulting engineer.

Armour & Co, Union Stock Yards, Chicago, Ill., plans power house at new multi-unit meat-packing plant at Houston. Bids will be asked soon. Entire project will cost about $1,000,000. Company engineering dept, first noted address.

Wharton plans municipal power plant, using diesel-generating units. Also for electrical distributing system. Cost about $290,000. Financing through Federal aid.

Cuero has plans for municipal electric plant of 1050-kw capacity, using diesel-generating units. Cost about $225,000, of which $101,000 will be represented by Federal grant.

Jasper plans municipal electric plant, using diesel-generator units and accessories. Cost about $175,000, including electrical distributing system. Financing through Federal aid.

Big Lake plans municipal gas-distributing system, with welded-steel pipeline for connection with main line of Texas Public Service Co. Cost about $28,000.

VIRGINIA——City Council, Lynchburg, plans extensions in power house at city hospital. Work will be carried out in connection with other expansion at institution. Cost about $175,000. Financing has been arranged through Federal aid.

Galax has concluded Federal financing in amount of $287,000 for new municipal electric plant, using diesel-generating units of 1600-kw capacity.

Board of Trustees, Virginia Polytechnic Institute, Blacksburg, plans extensions in power house at institution for central-heating. Work will be carried out in connection with erection of several new buildings at college.

Waynesboro is considering municipal electric plant and will make estimates of cost soon. Financing through Federal aid. I G Vass, city manager, in charge.

WASHINGTON——Water Bureau, Spokane, plans electric-operated pumping machinery and auxiliary equipment in connection with extensions in municipal water system. Cost about $780,000. Financing through Federal aid. Proposed to begin work soon.

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